WORKING WITH OLDER PEOPLE

Volume II	BIOLOGICAL, PSYCHOLOGICAL AND SOCIOLOGICAL ASPECTS OF AGING

a guide to practice

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MENT OF HEALTH, EDUCATION, AND WELFARE • PUBLIC HEALTH SERVICE

WORKING WITH OLDER PEOPLE:

a guide to practice

Volume I: The Practitioner and the Elderly

Volume II: Biological, Psychological, and Sociological Aspects of Aging

Volume III: The Aging Person: Needs and Services

Volume IV: Clinical Aspects of Aging

The volumes in this series were prepared from materials developed by the Projects Division, Gerontological Society, under contract PH 86-63-184 with the Public Health Service.

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Volume II	BIOLOGICAL, PSYCHOLOGICAL AND SOCIOLOGICAL ASPECTS OF AGING

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, Public Health Service,
Health Services and Mental Health Administration, Community Health Service,
Division of Health Care Services, Parklawn Building, Rockville, Md. 20852
April 1970

FOREWORD

"Working With Older People: A Guide To Practice" will, upon completion, be a series of four volumes designed as resource material for health practitioners who work with the elderly. This series is based principally on materials developed by the Gerontological Society under contract with the Public Health Service.

Volume I, "The Practitioner and the Elderly,"[1] focuses on aging and the world of practice related to aging. The publication puts into perspective the changing character and needs of the aging population and the implications of these changes for required programs and services. The many interdependent needs of the elderly are identified and correlated with areas of interdependence among practitioners who seek to meet these needs.

Volume II, "Biological, Psychological, and Sociological Aspects of Aging," is devoted to the basic sciences most directly related to the process of aging and the aged individual. *Biological aspects of aging* are discussed in terms of those physical characteristics which are affected by time and determined largely by genetic and environmental influences brought to bear on the individual. *Psychological aspects of aging* are discussed in terms of those functions used by the individual in adapting to his environment—his senses and perception, his ability to learn and remember, his responses, and his personality. *Sociological aspects of aging* are discussed in terms of the adjustment of the aged individual to society, with consideration given to the degree to which he is or can be influenced by family, friends, and community.

Volume II has been organized to meet the needs of readers with varying levels of interest. The general reader may wish to read only the perspective and the three brief overviews which comprise Part I. Others may wish to read the more extended treatments of the biological, psychological, and/or sociological aspects of aging contained in Part II.

Volume III, "The Aging Person: Needs and Services," deals with social welfare as it relates to health of the aged, and identifies those factors—biological, psychological and sociological—which significantly affect the aging process.

Volume IV, "Clinical Aspects of Aging," consists of: (1) a section dealing with disease conditions most relevant to single organ systems of the elderly; (2) a section dealing with the subjects of metabolism, nutrition, rehabilitation, drug therapy and laboratory values; and (3) a section dealing with special professional practices and the elderly person, including surgery, dentistry, nursing, physical therapy, occupational therapy and podiatry.

Special recognition is made of the efforts of Dr. Austin B. Chinn, formerly Chief of the Adult Health Protection and Aging Program, who recognized the need for these materials and who developed the means for producing them.

It is hoped that "Working With Older People: A Guide to Practice" will serve as a useful tool in continuing education activities which are so vitally needed to enrich the understanding of health professionals who work with aging and aged persons.

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[1] U. S. Department of Health, Education, and Welfare, Public Health Service, PHS Publication No. 1459, Vol. I. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 65 cents.

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- Psychological and Sociological Aspects of Aging

Almost 1 in 10 Americans is 65 or older, nearly 20 million persons. This number exceeds by a million the total population of our 20 smallest States.

By 1975, it is estimated that there will be 22 million aged—more if breakthroughs occur in treatment or prevention of cancer and cardiovascular diseases. By 2000, about 30 million will be aged. These figures clearly foretell part of the need for comprehensive services for the aged.

The fact that there are increasing numbers of persons 65 years of age and older has become common knowledge in recent years. But what has not been as widely recognized is the fact that people are living more often into the oldest ages. This is not to say that the outermost limits of human lifespan are expanding; it means that more people are approaching limits as we have known them.

Half of all people now 65 and older are about 73 or older; 6 percent are 85 or older—more than 1 million persons. In the years ahead, the increase will be particularly great at the oldest ages. With the population 65 and older projected to rise 50 percent between 1960–85, the population 85 and older may double.

The steady increase in the numbers of old and "older" old persons in the population is particularly significant in view of the fact that chronic disease, long-term illness, and disability comprise the bulk of the health problems of adults in their later maturity. Consequently the increase in the need for preventive and therapeutic services for this age group will be greater than the increase in numbers suggests. Physical diseases which disable or kill the greatest number of the aged are cardiovascular-renal diseases, cancer, arthritis, tuberculosis, diabetes, and glaucoma.

According to the National Health Survey, during the year ranging from July 1966 to June 1967, about 7 out of 10 persons between the ages of 45 to 64 (71.6 percent) had one or more chronic conditions, as compared with more than 5 out of 6 persons aged 65 and older (86 percent). The findings further reveal that the extent and intensity of physical disabilities associated with chronic disease increase sharply with age.

Variations among the age groups with regard to the mobility limitations provide a revealing yardstick. A person has a mobility limitation when he has difficulty getting around alone, when he needs special aid or help from another person in carrying out the activities of daily living, or when he is confined to the house because of a physical condition. Of the total population, fewer than 1 out of 100 of those under 45 are affected in this way, compared to 1 out of 20 of those 45–64, and almost 1 out of 5 of those 65 and older.

It is important, too, to keep in mind the fact that the aged more frequently suffer from a multiplicity of ailments.

This is the Nation's chronic disease picture by category:

—14.6 million adults have definite heart disease, and an additional 13 million have suspected heart disease;
—2 million are known to be diabetic;
—13 million report some form of arthritis;
—1.2 million have activity-limiting visual impairment;
—upwards of 500,000 new cancer cases are diagnosed each year;
—heart disease, cancer, and stroke account for more than 70 percent of all deaths in this country.

Costs. It is an undisputed fact that medical needs and the cost of meeting these needs rise with declining health, and that the impact of chronic diseases is greatest among the elderly. Of the total $41.5 billion health care bill for the total population in the fiscal year 1967, more than one-fifth ($9.2 billion) was used by, or in behalf of the aged who comprise approximately one-fourth of the total population. The rise in cases is only partly met by Medicare, which covered 35 percent of the health costs of the aged in 1967. Of expenditures for hospital care, 57 percent was through the Medicare program.

For many of the elderly, illness serves as a major cause of poverty by reducing their incomes; conversely, poverty can be a major contributory cause of illness when it serves as a barrier to receiving adequate medical care.

The high cost of medical care can also present a devastating burden to many elderly persons who have some income and some savings. Recent studies indicate that about 30 percent of the elderly have assets of less than $1000 each. Such persons may have sufficient protection through Medicare or other insurance to provide adequate protection for short-term illness; however, when long-time illness occurs, their financial assets may be quickly drained.

The elderly use more physician services than do young persons. The U.S. average for persons below age 45 is 4.0 visits per year, for those 45 to 64 it is 4.7 visits per year, and for those 65 and older it is 6.0 visits per year.

The elderly have more admissions to hospitals, and stay longer. For example, persons 65 and older account for 14.5 percent of hospitalizations, even though this age group comprises 9.3 percent of the civilian non-institutional population. The rate of hospitalization among the elderly has been increasing. The length of stay for the elderly is 13.8 days (as against 6.5 days for those under 45). Moreover, the elderly are prime users of nursing homes and other long-term care facilities. As home-health agencies develop, the elderly undoubtedly will be prime users of these, too.

The elderly use more prescribed drugs. The per capita expenditure for prescription drugs for the elderly was more than 3 times greater than that for those under 65. Moreover, the per capita expenditure for prescription drugs for the elderly with severe disabilities was nearly 3 times greater than for those with no disabilities.

Higher utilization of medical services and more expensive drugs by the elderly population can be expected. Not only is this population growing, but governmental and other programs for them—such as Medicare, Medicaid, union and management health plans—are breaching financial barriers to health care.

Demands for care become pressures for efficiency in the delivery of care. These pressures are mounting not only because of rising public expectations but also because of shortages of physicians, nurses, and other practitioners.

New knowledge that helps keep people well or helps restore them to health undoubtedly is needed. Besides the contribution to human happiness, such knowledge becomes a multiplier of manpower and facilities.

Research and practice. In this scheme, the study of aging holds significance for practitioners and patients. Gerontology studies the biological, behavioral, and social manifestations of aging. The gerontologist tries to determine what happens to the organism and groups of organisms as time passes. From the practitioner's point of view, the biggest questions for gerontology are: "Is there a mechanism of aging, as distinct from disease? Can the effects be prevented, modified, and repaired?"

Today, there are no definite answers. There may be one or more mechanisms fundamental to the manifestations of aging, including susceptibility to chronic disease. Gerontologists admit there is a big difference between "changes with age" and "changes due to an aging process." One biologist says that there is no single process which is known to determine aging.

Some investigators view any cellular change in an old person as an age change, regardless of disease history, environment, or nutritional, physical, or emotional condition. But other investigators define a true age change as one resulting only from factors intrinsic to the cell.

These problems of definition do not necessarily mean gerontology is an impossible science. But they do suggest it is a complex attempt at systematic understanding of myriad changes. Changes that come with age include alterations in the structure of cells, in their numbers, in the substances surround-

ing them, in the blood and the vessels that supply tissues and organs, in the organ systems and the regulating endocrinal and nervous systems they depend on, and in the system of systems—the whole organism. The organism's interaction with its environment, including social interactions, also must be considered for repercussions on its physical and psychological state.

The various facets of organismic change through time are hard to study. They require special research arrangements. Two handicaps are seen by a leading biological gerontologist. Much potentially enlightening reasearch on the biology of senescence is deterred, he says, because it does not fit in with two customary research approaches: the study of isolated, manipulable facets of problems and early publishability.

Vulnerability. Aging has been thought of as vulnerability to stresses. These may be disease, accident, or psychosocial events, such as widowhood, economic deprivation, and loss of social status. It may be that our oldest people are extraordinary survivors because of their psychobiological equipment, not only genetic endowment but also acquired abilities to cope with environmental stress.

Aging probably has a basic relationship to chronic disease, which is a growing challenge to research and therapy. Since 1940, death rates from heart disease and cancer have each increased by one-fourth. The U.S. rate for heart disease is among the world's highest. Among males in the productive ages of 40 to 54, mortality rates are substantially higher in this country than in other industrial nations and almost twice the rate of that in Sweden.

While chronic diseases have grown, death rates from infectious diseases have declined. Between 1910 and 1950 the death rate from influenza and pneumonia was cut 55 percent; it has since been halved again. But the rate of decline in these and other infectious diseases has slowed or stopped. Possibly, antimicrobial therapy has approached its maximal contribution to mortality reduction for the U.S. population in general, and for the aged, particularly, the limit of antibiotic protection apparently is being reached. It is likely that antibiotics cannot provide any further extension of protection for the highly vulnerable aged person.

Thus, despite antimicrobial therapy and other contributions to health, a basic death pattern still prevails. The Gompertz plot, a mortality equation formulated in the early Nineteenth Century, states that the likelihood of death doubles every eight years of adult life. This observation is considered one of the best indications of an underlying aging process, as distinct from disease.

Thus, aging may be looked on as the "invitation" to disease or accident. The particular disease resulting in death of the old organism may be one that ordinarily has only trivial consequences in the young organism.

Additional light is cast on this theory by a gerontologist who points out that although the diseases and debilities of aging differ from one another, they all accelerate some time around maturity and progress at roughly the same rates. While diseases of aging seem to involve different parts of the body and result from different agents, they kill large numbers of people in the same late decades of life. According to this gerontologist, such a finding indicates that responsibility for what are recognized as the major manifestations of aging may be caused either by one or by a small number of basic age changes in the tissues.

What could such basic change be? One approach to obtaining the answer has been to compare mortality rates for specific diseases with the rate for all causes of death. The specific rates which come closest to the all-causes rate appear to be more reflective of aging. For example, cancer appears less related to aging than cardiovascular-renal disease, which is most like the all-causes rate.

One scientist believes the process most likely to be central to aging—and to cardiovascular-renal disease, but not to cancer—is toughening of connective tissue, largely made up of a protein. This is

collagen, which comprises one-third of total body protein. The toughening (or cross-linking) of collagen molecules increases with age. The change is most rapid between ages 30 and 50.

Most of the diseases and debilities of age may tentatively be explained on the bases of small blood vessels becoming more rigid and a greater rigidity of organs because of age-related changes in connective tissue. In the view of this scientist, conceivably this could result in alterations of diffusion of chemical substances and reactivity of small vessels.

The scientist suggests that it is possible to consider each of the debilities and diseases of age, one by one, and give a plausible explanation of how collagen cross-linking influences their progression. He admits that this is far from proof, and that such theoretical explanations are easily criticized because of gaps in our knowledge of the cause-and-effect sequence which ends in a degenerative disease or abnormal physiologic function. Nevertheless, this authority is of the opinion that of all the possible basic mechanisms proposed as causes of aging, the greatest amount of evidence points to cross-linking of collagen—and probably of other fibrous proteins —as the most important factor.

The above-mentioned observations are presented as examples of gerontological thinking. Many other theories exist. Some scientists focus their thinking on changes in protein molecules outside the cell; others concentrate on changes within cells; and still others are concerned with certain intercellular reactions.

A fundamental substance in the cell nucleus is deoxyribonucleic acid (DNA). It is not only the stuff of heredity but it also embodies the instructions for protein synthesis. Ribonucleic acid transmits these instructions from DNA in the nucleus to polyribosomes in the cytoplasm, where protein is made.

The hypothesis has been advanced that mutations in DNA occur in cells randomly. A mutated cell produces proteins that are antigenic to the organism, that is, the proteins produce the kind of reactions that foreign materials provoke. Not all cells with mutations survive. But if they survive and reproduce themselves, they probably interfere with physiological function. (Moreover, if the mutation disrupts cell division, the stage may be set for uncontrolled growth, i.e., cancer.) Mutations in lymphoid cells may impair their ability to recognize normal protein. They may mistake some as foreign and produce anti-bodies that attack them.

If mutation produces either antigenic protein or faulty lymphoid cells, autoimmune disease is initiated, the theory holds. There is some evidence that autoimmune reactions occur more often in the older person. Antibodies have been found against gastric, heart, thyroid, and voluntary muscle tissue. There is believed to be antibody against insulin, and rheumatoid factor is suspected to be an autoimmune phenomenon.

Certain changes in tissue add weight to the concept of age-related autoimmune reactions. Amyloid, a white insoluble protein believed a product of immune processes, appears to accumulate in many organs with age. In heart, brain, and pancreatic tissue, amyloid is present in some degree in over 90 percent of individuals aged 65 or older. Lymphoid cell infiltration, which may represent an autoimmune reaction, is common in the organs of older people. The increase in beta globulins in older people may represent circulating antibodies involved in autoimmune reactions. Certain vascular reactions linked with immune states appear more often in the aged; these may contribute to arteriosclerosis and impaired blood supply to vital organs.

Again, as the cross-linking theory also suggests, the organism experiencing autoimmune reactions may become less able to adapt to stress. Death may result from causes trivial in the young.

Both the mutation-autoimmunity and the cross-linking theories remain to be confirmed as foundations of aging. They are not mutually exclusive. If either, or both, are confirmed, we might have a link between the Gompertz plot which deals with populations, on the one hand, and underlying phys-

iological degeneration in individuals, on the other. In other words, the acceleration of mortality in an aging population would represent the accumulation of certain physiological changes in individuals.

Only in some unicellular organisms is there a clear link between mortality curve of a population and alterations in physiological functions. The link in people has been hard to discern because not all changes are consistently downhill with age. Different changes occur at different paces, some peaking after adulthood to stay more or less constant, and others peaking in maturity to decline only after age 70 or so. Still other functions do not change at all with time.

A hypothetical link in people may also be obscured because some tissues and organs may regenerate in whole or in part or may have cellular reserves more than sufficient for a lifetime. People rarely, if ever, seem to die of old age, that is, a loss of function attributable to age related cellular depletion. Disease or accident, not senescence, is the apparent cause of death.

It has been said that the aging process itself may eventually be treated. How could this be possible? It has been suggested that even on the basis of present knowledge, it might be possible to lengthen the lifespan by prolonging the period of growth. The difficulty with this approach is that it would involve serious underfeeding of children in order to extend the time needed to reach maturity, and not many parents would be willing to cooperate.

The chemical cross-linking of collagen can be inhibited by a diet deficient in vitamin C. Another method is to feed the chemical beta aminopropionitrile. This chemical produces lathyrism, a disease in which collagen is too weak to maintain bones and blood vessels. The suggestion has been made that it might be possible to find a dose which just slightly slows cross-linking but does not cause lathyrism.

Life and death. Many basic questions are still to be answered in gerontology. Why do cells die? How does cellular performance change with the age of the cell, or the age of the host organism? What happens to the functional capacity of organs as they age? What factors in the early life of the organism —physical and psychological—tend to reduce its longevity? In what ways do personality, living habits, disease and various environmental influences alter the rate of aging?

Research on the manifestations of aging lies within many special fields of inquiry—cellular biochemistry, molecular biology, enzymology, ecology, psychology, sociology, and others. Because of dependence on the findings and techniques of such disciplines, gerontology has had to wait for data and concepts to develop before it could attempt to portray what happens to whole organisms as they age.

At the moment, gerontology is only beginning to offer the geriatrician systematized knowledge. Much gerontological information is of an "item" type, descriptive of how a particular function changes with age, such as loss of elasticity of the eye lens or of the skin. There is lack of information about interrelationships or patterns of change with age. Both the gerontologist and geriatrician would like to know if changes in several items are centrally related or are independent. For example, strength of hand grip and vital capacity of the lungs both decline with age. Meanwhile, blood pressure rises. Are these three items centrally related or independent?

Certainly, the geriatrician can learn much from the gerontologist. To show how knowledge that will influence patterns of geriatric care is generated, three clinical studies will be reviewed. All are noteworthy examples of the combined use of medical and other sciences.

Human aging. One of the most interesting and perceptive recent studies was done at the National Institute of Mental Health and published as "Human Aging: A Biological and Behavioral Study." This was a collaborative study by 22 investigators, including physicians, psychologists, mathematicians, and sociologists. It was an attempt to find out what healthy old age is like. Since aging was looked on as

"a characteristic pattern of late-life change ultimately distinguishable from disease and adventitious consequences of existence," this study represented an attempt to pick apart aging and disease.

How did they try to do it? They tried to find subjects approximating complete physical, mental, and social well-being. Few met the standards. However, 47 elderly men were assembled—27 without any observed evidence of major disease or only slight evidence of trivial disease, and 20 men with only slight evidence of disease with possibly serious implications, but so slight as to be undetectable in any but the most sophisticated examination.

If the 20 resembled the conventional picture of truly healthy old men, the 27 were medically extraordinary. The total group, in age from 65 to 91 with a median of 71, were community dwellers. About one-third had been workers; the rest were professional men, managers, business men, and clerks. The majority remained entirely self-reliant financially despite retirement and income reduction.

Psychiatrists found them vigorous, candid, interesting, and deeply involved in everyday living. In marked contradiction to the usual stereotypes of "rigidity" and of "second childhood," these individuals generally demonstrated mental flexibility and alertness. They continued to be constructive in their living: they were resourceful and optimistic. The group was not uniform, however. Some individuals showed maladaptive patterns of withdrawal and depression. Some showed evidence of mental decline.

Medically, both groups differed little from a comparison with a group of young persons of mean age 21. Both the 20 conventionally healthy men (Group II) and the 27 extraordinarily healthy men (Group I) shared certain differences when compared to the young.

Disease influence. The influence of disease made itself apparent in studies on cerebral circulation and metabolism. Whereas Group I resembled young adults used as controls in these studies, Group II had reduced cerebral blood flow and oxygen consumption. These were thought to be clearly related to arteriosclerosis, even when minimal, but not to hypertension without arteriosclerosis. In other words, disease rather than aging seemed to make the difference in cerebral circulatory and metabolic functions.

However, electroencephalography (brain-wave measurement) showed that both Groups I and II had slower dominant frequencies than the young, but Group II had the larger decline. This suggested that brain-wave changes are age-related but the changes are accelerated by disease.

The researchers suggested that at some point a disease, such as arteriosclerosis, becomes a pacemaker of decline. For instance, if arteriosclerosis is present, certain functions shift together—such as cerebral circulatory, metabolic, and electrical activity as well as other physiological characteristics. Without disease, the parameters do not shift together; presumably, this is the case with aging.

Tending to be more related to disease than to aging were such early manifestations of mental decline as decreased comprehension, memory, attention, and readiness to respond. However, some Group II members had very early signs of senility without atherosclerosis, cerebral circulatory and metabolic deficits, or other indications of pathological brain change. This indicated that social, psychological, and other experiential phenomena, as well as organic disease, have a role in senility.

Some personalities apparently could compensate for losses of wife, income, social standing. But others could not; these tended to show functional deterioration unrelated to cerebrovascular disease. The fact that psychiatric depression and slower psychomotor reaction times occurred together appeared to support the view that environmental influences may modulate psychomotor decrement. If disease is added, the decrement become precipitous.

Psychological indicators. Even minimal disease in Group II yielded a definite, though small, set of psychological as well as physiological differ-

ences from Group I values. But the psychological declines were more distinctive. This suggested that psychological measurements might be sensitive indicators of general health status. Loss in verbal ability seemed particularly good as a clue to incipient disease.

Verbal ability improved with age, contrary to the misconception that aging must signify decline in every function. The old men did better on verbal tests than young men. However, this was a departure from the general psychological decline that comes with age. Group I showed better verbal ability than Group II, suggesting that were it not for disease Group II might have had better scores. Decline in verbal ability when the men were re-tested seemed an index to a group of changes, including decline in cerebral metabolic oxygen utilization and 23 cognitive and psychomotor measures.

"Behavioral tests apparently are tapping physiological functions which we are not touching directly as yet," commented Dr. James E. Birren, a chief investigator and a participant in the investigation. "What these are is hard to say. Subtle change in cerebral blood flow may be one," he added.

Decline and death. Behavioral tests were given in 1956 when the 47 men were first examined, and in 1961 when 29 of 34 survivors appeared for reexamination. Sharp declines in performance on psychological tests, as later analysis showed, seemed to prefigure death. For instance, a Group II man who showed the largest decrement since 1956 was one of the early deaths. However, Dr. Birren said caution must be used: the tests are inherently limited because stresses may intervene and alter the physiological state after testing. Nonetheless, tests of cognitive functioning can be used as markers of subtle but significant change; with them, gerontologists can try to seek out key physiological and sociopsychological influences on the individual's vulnerability to disease.

The "Human Aging" study found that there is no single non-disease process which is central to aging. But the investigators noted that psychomotor slowing and decline in the brain's electrical activity appear to be among the clearest expressions of aging *per se*. These declines may be influenced by: (1) depression produced by environmental loss; and (2) such vascular changes as hypertension, since elevated blood pressure and psychomotor slowing occurred together.

Findings of this study indicate that the correlation between reaction time and blood pressure adds a further element in a group of relations that appear with advancing age between disease, environmental changes or losses, and the regulation of behavior and physiological functions by the nervous system.

While pointing out that "the interrelatedness of manifestations of aging remains a tentative matter," the investigators concluded that healthy old men were remarkably "young."

With control of metabolic diseases of later life, with improved understanding of brain syndromes and functional disorders, with more research to provide guidance on environmental and interpersonal elements necessary to optimal personality development throughout life, this type of "young" old person may become more common, they suggested.

Bethesda to Baltimore. The "Human Aging" study is a longitudinal investigation, one that compares the same group to itself at later times. (A cross-sectional investigation is one that compares two groups, such as young and old, at the same time.) Moving from the National Institute of Mental Health at Bethesda, Maryland, to Baltimore, we find another longitudinal study, also a Public Health Service undertaking. This is at the Baltimore City Hospital where the Gerontology Branch of the National Institute of Child Health and Human Development is located.

This branch has been described as the Nation's first comprehensive gerontological laboratory. Besides laboratory research on animals and plants, the branch conducts clinical studies of patients in a 60-bed research ward. Its activities cover cellular and

comparative physiology, endocrinology, psychology, nutritional biochemistry, human physiology, human performance, and psychology.

Under way since 1959 is a longitudinal study of more than 500 male volunteers aged from the twenties through the nineties. They report at 18-month intervals for 2 days of comprehensive testing, including medical examination and determinations of pulmonary, renal, brain, heart, and other functions. Nutritional, genetic, and socioeconomic information are collected. All the data are stored for computer analysis. The records are gradually telling the story of what happens to the human organism with age.

Generations of observation. "There are many questions we won't get a grip on for many years," says Dr. Nathan W. Shock, chief of the branch. "I don't expect to be around for all or many of the answers. This is what gerontology is, you see. Longitudinal studies of man may require several generations of observers."

The branch has compared the functioning of young and old groups. It has found these reductions in function when the average performance of persons aged 75 is compared with average performance of persons aged 30: renal plasma flow, down 50 percent; nerve conduction velocity, down 10 percent; maximum oxygen uptake in exercise, down 60 percent; maximum breathing capacity, down 60 percent; and cardiac output, down 40 percent.

These decrements lower maximum work rate by 30 percent. In addition, coordination among organ systems declines. Individual organs lose functioning cells, but the loss occurs at different rates in different organs. The biggest known difference between the old and the young is the difference in the number of the cells rather than quality of the cells.

These findings suggest that the aged individual has less functional reserve with which to overcome stress. From the practitioner's viewpoint, the data confirms that the challenge is to keep the individual from encountering debilitating stresses, such as disease and accident. The aged individual apparently has enough function to sustain at least most of the normal routines of life, especially in a society that has many aids to physical effort—elevators, automobiles, power tools, even stair-climbing wheelchairs (a recent invention).

Geriatrics West. From Baltimore we can go across the continent to San Francisco's Langley-Porter Neuropsychiatric Institute, which has a project called Studies of Geriatric Mental Illness. Physicians, sociologists, anthropologists, and others have studied 500 elderly persons admitted to a psychiatric ward of a general hospital and 600 drawn at random from census tracts. One objective was to determine why certain individuals required hospitalization while other elderly persons, many with the same conditions as those hospitalized, were able to continue living in the community.

These are some of the questions that were asked:

What roles do morale, environmental support, psychiatric and physical illness experienced over the lifetime, and concepts of aging play in keeping the old person on an even keel?

To what extent do socioeconomic class, educational level, and ethnic and religious values influence good adjustment to aging?

Do stereotypes of aging perform as self-fulfilling prophecies?

In the face of senescence, is geriatric mental illness an escape mechanism?

Are certain personality types more prone to geriatric mental illness because of particular social and physical stresses?

An excellent and highly readable report of this work is in "Lives in Distress," by one of the co-investigators, Mrs. Marjorie Fiske Lowenthal. One finding: Keeping older people physically well prevents or attenuates the expression of severe mental illness. Another: Organic brain disease need not exclude life in the community, and psychogenic illness may even be reversed with good medical, psychiatric, and social support.

This study further showed there is little factual

basis to the idea that families are eager to be rid of their aged; rather it showed most families wait too long before seeking psychiatric help. There does appear to be more tolerance for deviant behavior, short of violence, in the geriatric population, supported by statements like, "He's not sick, just old."

Another finding is that geriatric mental illness seen in the hospital is at the stage representing massive breakdown. While a young person's breakdown may stem from one important factor, or a few, the older person has a complex, proliferating pattern.

According to a psychiatrist who participated in the Langley-Porter study, 40 percent of acute brain syndromes are potentially reversible by medical management with supportive social services. This observation has led to the proposal that some community hospitals might well think of setting up acute brain syndrome wards operated by teams of psychiatrists, internists, and social workers.

Not only is there fear of psychiatric treatment among elderly persons and their families, but professionals apparently are reluctant often to deal with the elderly. Says Mrs. Lowenthal: "I'm inclined to believe that professional as well as public education is deficient on aging. I think professionals aren't aware of the possibilities of improvement in the elderly. Our data certainly do not support therapeutic nihilism. Mental problems in the aged are not necessarily steadily deteriorating ones. The response to almost any kind of therapy is striking."

Conclusion. We could continue this brief look at gerontological research with more stops across the country, but we have already covered much territory. This chapter began with some national statistics, projections, and mortality equations; then touched on a molecular and immunological theory of aging.

We went into the "Human Aging" study, the longitudinal study at Baltimore, and the Langley-Porter investigations. These are examples of broad studies involving several major levels of inquiry—physiological, behavioral, and sociological.

In moving between the macro and micro worlds, in delving into the various levels of human function and behavior, gerontology is generating information on a broad front—the kind of broad research front needed to support action programs for a growing aged population through the approach of comprehensive geriatrics.

BIOLOGICAL ASPECTS OF AGING

The Search. Man traditionally has been interested in methods of prolonging his lifespan. From the early searches of Ponce De Leon for the fountain of youth to the current day proponents of novocaine, the path of history is strewn with the relics of methods that were supposed to increase lifespan.

The sexual ardor of young animals has inspired many recipes for concoctions to increase lifespan. Preparations with a base including tiger testicle appear in many old Chinese pharmacopeias. In 1889, Brown-Sequard injected crude testicular extracts into himself and announced remarkable rejuvenating effects. Later, Steinach devised a method of tying off the spermatic ducts in males to increase the release of male sex hormones which were reported to have marked rejuvenating effects. About the same time, Voronoff transplanted testicular fragments from apes and goats into human beings which were reported to increase vigor and activity.

A counterpart of these early experiments may be found in the use of both sex hormones and other anabolic steroids in elderly people. Endocrine treatment may be necessary in specific individuals for certain medical conditions, such as hypothyroidism. But there is no evidence that promiscuous administration of sex hormones will effectively combat the general changes associated with aging.

Metchnikoff was firmly convinced that many of the ills of mankind, including old age, stemmed from the absorption of bacterial poisons from the intestinal tract. According to his hypothesis, a change in the bacterial flora of the gut would reduce the formation of poisons and thus increase longevity. To this end, yoghurt or acidophilous milk is highly regarded among some individuals. Reports of extreme longevity of inhabitants of certain areas in Russia gave further impetus to this hypothesis; in this population goat milk and yoghurt constituted a significant part of the diet. However, the theory has not received support in laboratory studies and there is even some question about whether ingestion of yoghurt induces a significant change in the bacterial flora of the intestine.

Another highly publicized nostrum for old age was antireticular cytotoxic serum introduced by Bogomolets, who believed that stimulation of the reticular system of the body would combat the effects of age. Subsequent research has failed to demonstrate the effectiveness of this therapy.

In the late 1950's, serial injections of novocaine were reported by Roumanian investigators to greatly alleviate many of the disabilities of elderly people. Subsequent tests in many different countries have not confirmed these reports.

In Switzerland, rejuvenating effects have been claimed following the injection of suspensions of embryonic tissue. However, the results have not been corroborated in other laboratories. Few investigators in the United States, at least, are willing to undertake the experiments because of potential hazards.

At the present time, there are no "anti-aging" treatments which are regarded as well enough established and without hazardous side effects to warrant general application.

Claims for rejuvenation must be viewed with caution. To establish the validity of a therapeutic treatment scientifically, large numbers of control and treated individuals must be studied and the evaluation of results should be based upon objective psychological and physiological, anatomical, biophysical or biochemical measurements.

For the practicing physician, conservative ap-

proaches should prevail until such time as rigorous scientific criteria and measurements of the effects of treatment are established. The attempt to provide a scientific basis for therapy is under way.

Aging and Senescence. Aging may be defined in its broadest sense as the sum total of changes that occur in an individual with the passage of time from birth *throughout the course of life.* This refers only to changes that are not attributable to accident or disease. Senescence is a more specific term. It refers to degenerative changes that occur *after maturity has been reached,* which ultimately culminate in death.

Theories of Aging. There are a number of theories of aging, some fanciful, others sound, but all still in formative, hypothetical stages. The total body of information available to the scientist is relatively meager and scattered. Fortunately, this body of knowledge is growing.

Mechanisms which influence aging fall into two groups, based on causative factors, namely:

1. The inherent or genetic factors which determine the time of onset, the course and direction, and the time sequence of the various aging processes.
2. Those insults and assaults of the environment upon the individual which tend to reduce his probability of surviving with the passage of time.

Much of what is known about aging and death can be described in an orderly mathematical fashion. Statistics about population changes are summarized in the form of "life tables" or mortality (or survival) curves. These provide important information about the average and maximum duration of life. Moreover, by pointing to the peak periods of mortality of a population, life tables give important clues as to the times in the lives of the individuals when particular systems are failing (i.e., the time of predominant occurrence of such conditions as heart failure, cancer, diabetes and cerebral vascular accidents).

Conversely, life tables can be utilized in a practical way to evaluate quantitatively the efficacy of new and modified therapeutic procedures in social or clinical medicine, by following the modifications in the rate of dying off, shifts in time of high death rate, and shifts in average and maximum lifespans.

Life tables for various animals, under controlled laboratory conditions, have been confirmed repeatedly. This emphasizes the underlying genetic control of aging, and, therefore, of lifespan. However, one still must keep in mind that longevity, aging, and finally death from old age are the result of the interaction of the inherited factors for survival on the one hand and the adverse environmental factors on the other.

Factors in Aging. Although no theory on the mechanistic background of aging is universally accepted, aging can be described in terms of the many observable changes which occur, more or less consistently, from individual to individual, with advancing time.

We can thus subdivide the two major groups of theories about aging as follows:

A. ***The genetic basis for aging in terms of:***

1. Cessation of growth and the failure to replace cells as they are destroyed or "die off."
2. Gradual failure of production of a juvenescent or growth substance.
3. Increasing production of an aging factor or hormone.
4. Depletion of essential cell or tissue components necessary for the maintenance of normal structure and function or errors in the function of cellular components.
5. Accumulation within cells or tissues of substances which may be chemically or mechanically harmful.

These are events which can be termed genetically programmed; that is, they may occur progressively and inexorably as time progresses in the life of the organism, more or less independently of the environment.

B. ***The extrinsic or environmental factors which may contribute to or accelerate aging, such as:***

1. Disease in its broadest sense including bacterial, fungal, animal parasite, and viral infections.
2. Physical trauma or injury including mechanical, chemical and thermal changes.
3. Radiation effects of a cumulative and dramatic nature.

4. The adverse influences of other animals; in the case of man, his interaction with other human beings.

What makes it difficult to interpret the known data concerning the biology of aging is the fact that even within one species of animals, there are individuals with different genetic constitutions, each likely to respond differently to different environmental conditions according to his particular genetic make-up. Moreover, it is quite unlikely that a single factor or process may be underlying all of aging from birth to old age. It is probable that a number of factors—some building up or maintaining the organism, some tearing it down—may be so operating, to a greater or lesser extent at different times in the individual's life, to achieve his paticular pattern of aging and ultimately death in old age.

Signs of Aging. An aged human being usually can be recognized by the appearance of his skin and hair, his speed of movement, his gait, his posture and the degree of loss of his vigor and vitality. Nevertheless, these are only the reflection of a number of inner changes in structure, in chemical make-up, and in functional effectiveness of various organs of the body and their component parts. This likewise may be true for, and has been observed in, lower animals. Thus, the loss in the ability of older people's limb muscles to respond quickly and vigorously is paralleled by the loss of flying ability of some aging insects.

Yet underlying such gross functional failure are certain known structural changes which have been described to a limited extent in man, but much more in animals, which can be studied under controlled conditions. And laboratory animals can be inbred to obtain genetically pure lines. Because people live under diverse conditions of temperature, diet, sanitation and other environmental influences and because they have diverse genetic make-ups, an adequate picture of the fundamental nature of human aging has yet to emerge from clinical findings, family records, and vital statistics.

Thus, much of the biological information about aging comes from studies of lower animals. Their shorter lifespan allows relatively rapid assessment of age changes under controlled conditions. Nevertheless, these animal cells and tissues are similar enough to human cells and tissues so that, with some qualification, the information about them is meaningful to human aging. Cells of the central nervous system are incapable of self-duplication. Both in people and in lower animals, there is a gradual reduction in the number of these cells, with some changes occuring within those that survive. Striated muscle is said to lose mass with age. Little is known about the intracellular changes in aging muscles.

A rather universal observation has been the accumulation of specific (lipofuscin) pigments in the nerve cells of senile mice, rats, and people. These pigments also occur in liver, myocardium, and other cells. The role of these pigments is as yet unknown.

A decrease occurs in the concentration of certain enzymes in human aortas, in rat and mouse liver, in rat kidney, in human and female rat plasma, and in the flight muscles of insects. But the activity of other important enzyme systems remains unaltered, for instance, in the liver of senescent mammals and in the brain of senescent honey bees.

At present, then, there are known only a few points of significant correlation between a failing enzyme and declining function of a particular organ or structure in aging lower animals as well as in human beings.

Since certain degenerative age-dependent diseases like atherosclerosis involve structural changes, research attention has been focused on the physical aspects of aging tissues, particularly supportive (connective) tissue. The elasticity of human skin decreases with age. This appears to reflect deterioration of collagen fibers of the underlying supportive tissues of the skin. The deterioration gives the skin a wrinkled and flaccid appearance. A similar loss in elasticity of large human arteries occurs. This has been related to the change in characteristics of collagen as well as calcification of the elastin in the arterial wall.

Structural changes in the skeletal system underlie stiffness and inflexibility of joints. Cartilage loses water and joints fuse at the cartilage surface. Possibly, metabolic by-products accumulate with age and may help to promote cross-linkages, especially in the connective tissue collagen.

Physiological changes. By and large, the blood of aging persons remains within normal ranges as

to salt content, protein and acidity. Total blood volume is fairly constant as well. Blood cholesterol, however, actually begins to fall substantially after age 60, despite a rise throughout adulthood to a maximum level at about 55-60 years of age.

Up to about age 70, there is a progressive increase in resistance by the blood vessels to blood flow. A rise in average blood pressure values with advancing age accompanies these changes. Decreases occur in renal blood flow *per se* and in cardiac output, basal metabolism vital capacity and even conduction of nerve impulse.

There are many constancies of function in the resting individual of advanced age. However, the ability of the aged human to withstand stresses upon these same functions may be quite diminished. For example, alterations in the sugar content and acidity of the blood in old people are overcome more slowly and less completely than in younger people. Similarly, changes in pulse rate and in respiratory minute volume in older people are much more pronounced (and recovery to normal much slower) following exercise than in younger persons.

Lowered muscular strength and reduced reaction time are well known concomitants of senescence, as is lowered maximum breathing capacity and reduced capacity to adjust to changes in temperature of the environment. Nevertheless, there is considerable variability from individual to individual of the same age group for each of the functions described. That is to say, the biological or physiological age of the heart, the kidney, the lungs, or even the nerves of one individual of age 60, for example, may differ by as much as 50 percent from the same tissue or organ in another person of the same age. It is equally well known that in the same individual, one organ may age at quite a different rate from that of another. For example, the kidneys of a 70-year-old may be functioning as inefficiently as those of an 80-year-old person, whereas his heart may be functioning as well as that of a 60-year-old individual.

PSYCHOLOGICAL ASPECTS OF AGING

A growing body of evidence, with important implications for practitioners in the field of geriatrics, is being gathered from studies of changes in mental test performance as a possible indicator of incipient disease or imminent death.

One such study, at the National Institute of Mental Health, compared the behavioral test results of a group of healthy old men and a group of old men with slight evidence of serious disease, such as atherosclerosis. The healthy group had higher scores on tests of cognitive function. On re-examination some years later, however, both the healthy group and the slightly diseased group demonstrated large declines in their test results. Moreover, there appeared to be some evidence that faculty performance in the cognitive function tests, particularly when sharp declines in test results were noted, was related to approaching mortality.

These results are preliminary. Several studies are being conducted at a number of centers around the country in an effort to find evidence from which definitive conclusions can be drawn about the use of psychological tests as predictors of health status.

Nevertheless, there is speculation that the central nervous system, the body's great communications network, reflects not only disease but also aging, or vulnerability to disease and other stresses. Recent studies have produced important evidence concerning its possible role as a pacemaker and/or central indicator in the processes of aging.

For example, neurons—the cells that make up the nervous system—do not divide. In contrast with skin cells, neurons are as old as the individual. Neurons are thought to play an important part in aging because they serve to integrate the various functions of the body. Thus, they can spread the effects of their own age changes to other organ systems and remote tissues.

Then, too, subtle changes in cerebral circulation, brought on perhaps by atherosclerosis, may damage other parts of the central nervous system as well as important areas of the brain itself. This may be reflected in the aging organism's decreased reponsiveness to the environment.

The senses—hearing, sight, taste, smell, touch, balance—become less sharp with age. Disease and repeated injuries of ordinary living (such as loud noise levels at work) account for part of the loss, but aging itself probably accounts for a good deal. There is a general slowing down of responses, manifested as reduced ability to handle complex activities and unfamiliar tasks.

Given such psychological changes, could one infer that old people are psychologically handicapped?

If performance at the upper limits of capacity as seen in early maturity is taken as the standard, the answer almost certainly would have to be yes. However, people rarely are called on to operate at the limit of their capacities, physical or mental. For many reasons, the reduction in sensation does not necessarily mean impairment in behavior. Most stimuli, for example, are far above the ordinary threshholds of perception, leaving a good "safety margin" for perceptual fading. People can compensate with devices (such as spectacles, stronger lighting, hearing aids). The modern world often provides elevators, automotive transportation, and other technologies that make losses in ability to move rapidly, for example, irrelevant to ordinary living. And the individual can shift from speed to accuracy of response in the kind of occupations or hobbies he pursues.

The older person may even be superior in some respects. If achievement is defined apart from performance in which youth excels, aging may be considered to contribute positively to those fields where life experience, maturity of judgment and accumulation of knowledge are relied upon, such as in musical creativity, medicine, philosophy, and politics. Long after physical capacities have receded

from their peak, psychological and social skills may still be ripe.

An example of the superiority of older persons is seen in the results of the NIMH study comparing the healthy old men with a group of young men. The older group lagged far behind in psychomotor performance but had higher scores in tests of information, comprehension, and verbalization.

This provides further evidence against the myth that impairments of memory and learning abilities are normal concomitants of aging. It has been shown that aging per se has little effect on learning ability, and that where such impairment does exist, it is more likely to be the result of some prior incapacity or debilitating health change in the individual.

It is true that the adult can, after leaving school, lose the attitude of seeking to learn. As the years go by he tends to solve problems on the basis of what he already knows and is not inclined to change his approach—even in the face of information suggesting that he should. This "rigidity" or refusal to change was at one time thought to be related to aging. Current evidence, however, suggests that the level of rigidity in an individual is associated with the extent of schooling and the number of years that have passed since school was attended. Furthermore, the greater the person's intelligence, the less likely he is to be "rigid."

Two points should be noted here in relation to education. First, today's elderly persons grew up in an era of resources and demands for education far different from those experienced by today's young and middle-aged. So our concept of "elderliness" may very well have to be changed because tomorrow's elderly will have more education. The second point relates to the fact that as a student, the individual is sensitive to the quality of his performance in response to external demands. That is, he is an inventive problem solver. As he ages, he acquires routines to meet demands of life and tends to lose this inventiveness. His repertory of responses may be adequate but stale. There is some evidence that the thought processes of older adults tend toward simple associations rather than toward analysis, and the weakness in solving abstract problems seems to be related to a reduction in the tendency to generate hypotheses about the nature of a problem and an orderly checking out of facts.

Many problems are created for the elderly because society reacts not on the basis of scientific knowledge but according to the myths and stereotypes with which it has surrounded "old age." Involuntary retirement at age 65 may be a crushing blow to the man who has many years of productivity ahead of him and wants to keep on working. And if, in addition, it results in a severely reduced income, somatic illness may soon follow retirement. The blows to ego, pocketbook and body may set the stage for mental problems or expose personality difficulties.

One of the most myth-shrouded areas of aging is that of mental illness. For many years, senile brain deterioration has been thought of almost as a normal concomitant of the passage of time. It is true that brain disease in late life occurs more frequently than do the mental illnesses of early life. Even so, only 1 or 2 percent of the total population may be expected to be institutionalized for mental disease late in life.

Further, it has been found that mental illness in older persons can occur as a side-effect of somatic illness. Infectious diseases and malnutrition can cause metal symptoms that remain long after the original condition is controlled.

As a result, geriatric psychiatry is placing more emphasis on seeking mixed causes of mental illness in older persons, taking into consideration possible interactions among physical illness, mental illness, and social illness. Problems of health, finances, and loss of spouse often arise in retirement when the individual has fewer resources with which to solve them. He or she begins to lose hope. As problems are solved less and less adequately, anxiety not only emerges but grows, becomes itself a barrier to successful problem solving, and spreads to the family.

The practitioner should be alert to the existence of the kind of patient whose personality or adaptive style gives the appearance of being psychopathological—but isn't. There is a way of adapting to life's uncertainties by simply denying their existence. It may not be the best way, but it may nevertheless have brought a degree of stability and even success to this particular individual.

One extensive study of personality showed at least three clear-cut types associated with high life satisfaction:

(1) The "mature" type includes individuals who accept the facts of aging, adjust well to losses, are

realistic about their past and present lives, and face death with relative equanimity.

(2) The "armored" type includes persons who cling to middle-aged behavior patterns, deny aging, keep as busy as ever, and manage to get along very well.

(3) The "rocking chair" type, which is growing as society becomes more leisure oriented, includes persons who accept passivity, sit and rock without feeling guilty about it.

There are many pitfalls awaiting the unwary practitioner in the field of the aging personality. Besides social losses, the practitioner should always be sensitive to the fact that individual physiological changes, including central nervous system changes, can dramatically affect emotional life and response patterns.

One should always be curious when an individual who has always been shy and withdrawn suddenly becomes markedly outgoing. Or when someone previously relaxed and composed becomes chronically anxious. It is possible that somatic changes are at the root of the personality change. Such somatic changes may have nonspecific outcomes or diffuse effects upon the rest of the body, such as the kind of central nervous system changes referred to earlier. The person may be placed in an uneasy relationship with his own body with the result that he becomes suspicious and anxious.

A new area of research interest is the relationship of behavior patterns to the likelihood of developing chronic illness in late life. Studies suggest that early life behavior patterns may be related to the probability of developing cardiovascular disease. For instance, restless individuals who are bothered by the pressures and urgency of time have a tendency to become hypertensive.

It is possible, therefore, that inclusion of personality characteristics in the medical history might lead to the development and application of more effective control measures. Practitioners of the future might give psychological performance tests as part of conventional health screening procedures. An abrupt change in test scores might be the cue for intensive examination.

One of the areas where stress seriously taxes the individual physiologically is bereavement. There is an increased mortality rate among recently bereaved persons. It has been suggested that health workers should attempt to see the individual several times during the early months and at least twice during the second six months following the death of the spouse. Measures aimed at cushioning the physiological and psychological consequences of bereavement should be a new focal point of health activities.

Are elderly persons inordinately anxious about death? According to stereotype, yes. But the fact is that younger persons are more likely to be concerned about death. Older individuals are probably more worried about money.

The terminal phase of life is an area that has just begun to be investigated in an objective way, and the results raise some surprising psychological issues. Reactions to imminent death vary as much as reactions to familiar life circumstances. But research has shown that during the last few months of life the individual has an increased feeling that his body is inadequate. The dying person experiences a growing feeling of helplessness because of loss of influence over his environment, but he has an increased interest in other people. A study comparing interviews (1) with persons who died within a year and (2) with those who survived showed that the individuals closest to the time of their death showed a much greater interest in their immediate environment. Information such as this suggests that perhaps the greatest disservice that can be done to the dying person is to isolate him.

To deny the dying person access to others and to the information of his normal environment, therefore, would seem to reduce the likelihood that he will resolve his own departure with dignity. Isolation of the dying is, perhaps, a reflection of the attitudes of younger professionals who are disquieted by their own unresolved conflicts. The social and psychological, as well as the physiological, concomitants of dying should be considered carefully in designing services for the terminally ill persons.

All those concerned with the care of the aged person should see him as an individual. To deal rationally with the problems of aging, a variety of biological, psychological, and social factors must be taken into account. The practitioner needs to be aware that averages and stereotypes are far less valuable in assessing the elderly person than in assessing the young. The range of variation is greater, and this means that the challenge is greater.

SOCIOLOGICAL ASPECTS OF AGING

When is a person "old"?

The physiologist and psychologist are harder put to provide a definite answer than is the sociologist. His broad answer is: When society defines the individual as "old".

Our society is becoming more and more explicit about it. "Old" increasingly means "old enough to retire," and that age has been popularly regarded as 65. In recent years, however, more than half of the men retiring have done so before age 65. In 1968, only 43 percent of the male workers age 65–69 were still in the labor force. For women the figure was only 17 percent. Labor force participation dropped off even more rapidly for those 70 and older.

Declining health and energy are leading factors in the decision to retire. Employer policy and layoffs are much lesser factors. Increasingly, people tend to retire voluntarily while in good health and able to enjoy leisure. The fact that retirement income is available—usually at age 65—plays an important role in the decision to retire.

Early retirement. The retirement age is going down. Under Social Security and some private pension plans, a worker may retire at age 62. Some union-management contracts provide for retirement at age 55.

Paradoxically, one might say retired people are getting younger. But the point also can be made that a person can be "old" in his twenties. A swimming star may be "old" that early. A baseball star is "old" in his forties, a football player even earlier. Yet a symphony conductor, who may only be approaching his prime at 60 or 65, is not thought of as ready for retirement until a decade or so later. Thus *when* a person is old depends on the role or roles in which he performs. The 65th birthday is a social, not a biological, event.

The meanings people attach to that age influence not only their behavior toward the 65-year old, but his attitude toward himself. These attitudes often work to limit a person's range of major activities. When we think someone is "old," we exclude him automatically from certain activities. When he reaches retirement age, we retire him from work and, except for emergency labor shortages, stop thinking of him as a worker, regardless of his wishes or capacity.

Yet in our society, work is one of life's central pivots. It is a keystone of a variety of roles: colleague, breadwinner, salesman, company representative, etc.

Replacing work. Apparently, more and more persons anticipate retirement and happily replace the work roles with others. But often, loss of work roles may be crippling socially, psychologically, and economically to the unprepared individual and his family.

While some older workers are, in effect, retired by poor health, prejudice can make a worker "old" before 65. Some workers past 45 are unemployed, not because of illnesses, but because of prejudices about health status or physical capacity. The U.S. Department of Labor studied reasons employers offer for age limits on hiring. Physical incapability was the most stated reason. Yet 70 percent of those advancing this reason had no studied basis for it. So jumbled are such practices that some employers willingly hire older workers for jobs that other employers insist are beyond their capability. Ironically, many employers rate their own older workers as highly productive and dependable, but refuse to hire new employees in the same age range because of an opposite age stereotype.

Age limits on hiring typically disregard individual abilities. They seem to reflect the status of the labor market. When the Department of Labor asked when employers might lift their age restrictions, they responded they would when they could not get enough younger workers. Thus, supply and demand for skills, not even beliefs about aging, can make a person "old."

"So far as the allegedly key issue of physical capability is concerned," the Department said, "a comprehensive review of available medical and psychological evidence reveals no support for the broad age lines which have been drawn on the basis of claimed physical requirements."

Poor health. The report noted that while older workers as a group do have poorer health than younger workers, many older workers do retain good health; the range of individual differences in health increases with age. It is unreasonable, the report said, to reject all older workers because statistics show greater prevalence of chronic conditions in older populations.

Besides age prejudice, one can find other reasons why many older workers remain out of work or are on the verge of retirement by unemployment. In general, today's older worker is less educated than his younger counterpart. Levels and types of skill sufficient in yesterday's labor market may be unwanted in today's. As our technology becomes less and less "blue collar," the number of industries that utilize workers with marginal educations is dwindling.

It is also true that even when these workers reach retirement age, their pensions and Social Security benefits—reflecting their earnings—are not very high, and retirement means a drop toward, or further into, poverty. The overwhelming proportion of people retiring today receive total pension income —from both public and private pensions—which is only 20 to 40 percent of their average earnings in the years prior to retirement.

To be "old" for today's elderly is more often than not to be a neighbor of poverty. In a society that puts a high value on work and money, to be "old" is to be on the periphery.

Loss of companions. For some persons, the loss of work companionship may be as important as loss of income. If active in his union, company, or professional group, the elderly person upon retirement probably is removed from long-time social relationships and meaningful activities. The male retiree often may find himself "in the way" at home. He becomes less effective in community work by reason of loss of contacts. Reduction in income restricts participation in certain activities; for instance, he may be unable to afford carfare to a senior citizen center.

These losses are felt keenly. Witness these retiree comments: "I'm 72. 'They' made me quit the job seven years ago, and I've been sitting around the house doing nothing ever since. What is a man supposed to do?"

"I'm 69 and a damned good machinist, a lot better than some of those youngsters working in the plant now. I'm good as I ever was. How come 'they' made me quit?"

These comments emphasize that the work people do establishes their positions in society. Change in economic role, and therefore of status, is particularly important to men. Being a non-worker and limited breadwinner has implications for the male's authority as a father. The male may begin to see himself as others see him: as out-of-date and socially irrelevant.

For better or worse. For women, retirement of the breadwinner can be difficult. She must cope with the unaccustomed constant presence of the husband, a situation put forcefully by one wife: "I married him for better or worse, not for lunch!" Relatively few older women today have business careers. Their major roles are primarily home based. Adjustment to loss of a major role—specifically, being mother to a child at home—occurs much earlier than the husband's retirement.

Despite physical vigor, an elderly person may reduce certain activities that cost money or are sustained largely by job relationships. He attends the theater less. He is not sought out for certain church activities. Expectations are reduced, activities are reduced, and, in turn, expectations drop. Some people fall into this cycle; their personalities may be predisposed to it and the attitudes of others may reinforce it. Chronic conditions that are not necessarily limiting in a major way may become a vehicle for attention, an excuse for inactivity, a reason for acting "old."

Thus, retirement and other factors related to age

can create problems not only for the elderly but also for society. Social Security, pensions, Medicare, medical assistance, subsidized health and housing services, income tax deductions, cutrate bus fares, and other efforts—private, governmental, voluntary —are some of society's ways of supporting a growing elderly population.

Social decisions about the elderly are often hard to make; witness the fight over Medicare. Profound questions are raised and debated about the allocation of national wealth among those who are dependents (i.e., children and aged) and those who support them; about the manner of support (public assistance vs. social right); and about channels of support (family, philanthropies, fraternal orders, industry, and local, State and Federal Government).

Labels and facts. We cast our labels and generalizations of an "elderly population" on the basis of an age determined by socioeconomic policy, not biological fact. For some purposes, in spite of the great variations among people, the 75-and-over age might be a more useful statistical breakpoint. In this group, there seems to be much greater need for medical and other assistance, and the proportion of women, especially widows, steps up considerably.

Nonetheless, sociologically, age 65 is a breakpoint.

What are the characteristics of this elderly population, so largely non-working? The 4 million elderly who work, about 20 percent of the older population, are fairly well off; they account for nearly 30 percent of the aggregate income of this population. On the other hand, 30 percent of the elderly are poor. In 1967, half of aged families had incomes under $3,928, and half of the elderly living alone or with non-relatives had incomes under $1,480.

Illness strikes the elderly far more frequently than it does younger age groups. Approximately 80 percent of the elderly—as compared with 40 percent of those under 65—suffer from one or more chronic diseases and conditions. Arthritis and rheumatism afflict 33 percent; heart disease, 17 percent; high blood pressure, 16 percent; other cardiovascular ailments, 7.5 percent; mental and nervous conditions, 10.5 percent; hearing impairments, 22 percent; and visual problems, 15 percent.

Families. Older adults often become dependent on their grownup children for care, physical and financial, as well as for affection. However, the proportion of elderly persons living with adult children is declining. The trend toward separate households does not mean a breakdown in family affection. The elderly tend to live near one adult child and visiting is frequent.

A sidelight: The 1960 census revealed 28,000 elderly persons living in *their* parents' household, a doubling since 1950, and 33 elderly persons reported they were grandchildren of the head of the household. A slow rise has occurred in the proportion of elderly persons in nursing homes, chronic disease and mental hospitals, and other institutions, from about 2.5 percent in 1940 to 4 percent in 1960.

Most of the elderly (61 percent) live in metropolitan areas, principally in the central city (33 percent). But older people also form a growing proportion of the farm population, for although the elderly are migrating to cities, younger persons migrate faster. More than 10 percent of the U.S. farm population is elderly. Contrary to the trend in the country as a whole, elderly men exceed elderly women on the farm. Men represent 43 percent of the older population of the Nation but 53 percent of the older farm population.

Other facts. Very often the elderly are in substandard housing, largely in depressed urban areas. Half the elderly have little beyond an elementary school education. The proportion of the elderly who were foreign born or who have at least one parent foreign born is 38 percent.

The old age population is growing—growing as a proportion of U. S. population, and growing older. Half of today's 20 million elderly are more than 72 years old, and almost 1 in 5 is over 80.

The elderly population is predominantly female and becoming more so because women are outliving men increasingly, even though life expectancy for both sexes is rising. More than half of older women are widows. Most men live in families with their own spouse. Only a minority of elderly women do.

These statistics represent only clues to the realities of the elderly population. The statistics imply that the retirement years are quite demanding: they call on the elderly to change roles and status in a society that emphasizes youth. For many elderly persons, the shift is from independence, participation, and leadership to dependence, passivity, and

exclusion—not only in economic and community life but also in the family. Many elderly persons live in a world dominated by leisure time but with reduced income and increased chance of ill health.

Suicide among the elderly has long been a concern of gerontologists. The male rate increases throughout the lifespan to about 60 per 100,000 at age 85 and older; the rate for females takes a "bell" shape with a peak rate of 12 per 100,000 at age 45-54.

Trying to adjust. In the broadest strokes, this is the kind of population with which health practitioners are dealing. An elderly patient often is a person trying to make a major adjustment to retirement; adjustment to a life without paid employment, the life he has known for decades, is not likely to be easy. Some persons make better adjustments than others. Some do not adjust well at all and may very well adopt a sick role or magnify their illness in search of sympathy in a world they perceive turned cold and unattending.

Health workers generally receive an unbalanced view of the elderly. They tend to interact almost exclusively with the aged who are ill and weak, and therefore in the greatest need of special services. It should be remembered that most of the elderly persons are relatively healthy.

To have thorough understanding of older people, practitioners should see them as members of society and its social systems, including kinship groups, neighborhoods, and communities.

BIOLOGICAL ASPECTS OF AGING

POPULATIONS

Diverse patterns of aging exist in nature. Scientists see this diversity among vertebrates and invertebrates, annual plants and insects. They see it through the eyes of statistics, specifically with a mechanism called the life table. Basically, a life table is a survival schedule for a defined population. Life tables can be used as gross probes for patterns of aging and hints of what causes them.

In annual plants and insects, death is the last in a rapid sequence of reproductive and developmental processes, and its proper timing is essential to the efficient completion of the reproductive act. Here we can find evidence that definite life termination processes are present, and are under effective control of genetic mechanisms which are responsive to the environmental circumstances with which the species is confronted. Other clear-cut instances of programmed aging are the life termination processes in renewable parts of organisms. The falling of leaves and fruit is the result of such programmed aging processes, as is the death of the red blood cells at a characteristic age (120 days in man).

For all mammalian species kept under good environmental and nutritional conditions (e.g., laboratory and domestic animals, civilized man), death rates are relatively high in the prenatal, neonatal and infantile periods. They decline rapidly, reaching a minimum value at an age which corresponds roughly with the species' puberty. In young adulthood, rates rise slowly. After this—e.g., from age 30 in man—mortality rates rise ever more rapidly with increasing age, by a law of geometric increase which behaves like compound interest.

In man, for example, the mortality rate doubles about every 8 years after age 30. The *doubling time* for the thoroughbred horse is about 3.5 years, and for the laboratory mouse it is about 3 months. Man, thoroughbred horse, and mouse have average lifetimes of about 70 years, 20 years, and 2 years, respectively.

This increase of death rate with age is an expression of the progressive aging of organisms structurally and functionally.

If each species could retain throughout its lifetime the minimum death rate that it achieves at about puberty, then each species would live about 100 times longer than it does. But man, horse, and mouse would still have about the same ratios of average longevity. Thus, the rate at which a species ages and its minimum mortality rate are related. And mammalian species under good nurture all have survivorship curves of the same sigmoid (S-shape) form, differing only in time scale.

Life tables for animals in the wild differ from those for captive animals in one important respect. Death rates in the wild are much higher, due to predation, starvation and harshness of the environment. Field mice have average lifetimes from birth of only a month or 2 as compared to 20 to 30 months for their laboratory cousins. Wild rats, on an average, live 9 months while those in the laboratory survive 36 to 40 months.

Animals in the wild rarely live to ages at which senescent change becomes manifest, but the small proportion of wild animals that do reach advanced ages show the same kinds of age changes that are seen in captive animals. The same is true for primitive man. Thus, aging is not a "product of civilization," even though different kinds and degrees of civilized environment do materially affect the course of aging.

What factors influence aging of a population? The survival of a species in the wild must be viewed in relation to its entire environment. There are com-

plex patterns of interaction generated by the struggle for existence; predator and prey species go through interconnected cycles of abundance and scarcity. Description of this requires not a single life table but a set, in which for each age there is a mortality rate for each phase of the abundance cycle.

Temperature of the environment is important. Fish, reptiles and all invertebrates have body temperatures little if any higher than the temperature of their environment. As temperature increases within their tolerable range, their metabolic rates increase. The sequence of senescent changes also proceeds more rapidly, so life expectation decreases as temperature increases. This is an important line of evidence supporting the concept that aging is less a matter of elapsed calendar years than it is a matter of the expenditure of vital energy—the so-called *rate of living.*

Mammals all have nearly constant body temperatures (in the range 96–100° F.). Maintenance of this constant body temperature imposes a higher rate of living on smaller mammalian species, and there is a precise inverse relation between body size and metabolic rate. If one compares body size and maximum lifespan over a wide range of species, one finds a tendency for larger species to have longer doubling times of mortality rate and to be proportionately longer lived than smaller species.

However, there are gross deviations from the rule. Man lives about 3 times longer than the rule predicts. If brain weight as well as body weight is taken into account, the overall discrepancy between observed and predicted lifespan is considerably reduced, and man is brought into line with the other mammals. The lifespan a species can attain apparently depends in part on its rate of living and the precision or adaptiveness of its integrated vital activities.

Life table functions can be constructed for deaths from specific causes as well as for all causes combined. These show that the greater part of the mortality of infancy and childhood is due to infectious diseases, whereas the degenerative diseases do not begin to take a toll in man until the fifth decade. Mortality from infectious disease does not increase with age as rapidly as does degenerative disease mortality.

The effect of improvements in disease prevention and cure over the past century has been to reduce the mortality rates at early ages by a large factor. Mortality rates of late ages have not been reduced very much. Hence the death rate curve rises more steeply and the survivorship curve stays up longer, but declines more abruptly.

Despite the improvement in survival at early ages, the maximum age to which people or animals live has not increased appreciably, even though the expectation of life from birth has doubled over the past century.

FUNCTIONAL CHANGES IN MAN

With age, death rates in a population increase. The incidence of many diseases—such as cardiovascular disease and cancer—increases with age. These diseases generally take a long time to develop, and for this reason appear characteristically in older people.

But this is not the whole story. For the individual himself changes with time in ways that we believe increase susceptibility to certain diseases. Aging and disease are not synonymous. At least, we don't think so.

We regard age changes as those alterations found in individuals without diagnosable disease states. Quite possibly, changes attributed to aging may be recognized in time as the early signs or stages of specific disease processes. Speculatively, we can think of aging as paving the way for any of a variety of diseases. In this sense, diseases may be a sign of aging. In any event, in describing changes that take place with time among people, we may want to include persons with disease as part of the aging population.

To characterize age changes, repeated observations must be made on the same individual as he moves through his lifespan. This is the longitudinal method (longitudinal in the sense of moving along the axis of time, as against cross-sectional investigations in which individuals of different ages are compared). The method, the hallmark of gerontological research, is expensive and extremely difficult to carry out. It is time-consuming, especially in man, and it cannot be applied where sacrifice of the animal is required for measurement.

Few results of human longitudinal studies are yet available. However, the method is essential to avoid the effects of mortality differences when different groups are compared using such factors as race,

age, income, health status and education. In a longitudinal study, because the individual is compared to himself at a previous age, these factors are not variables for which adjustments have to be made. Most of our knowledge about aging is based on cross-sectional studies which are open to bias from general cultural, economic, environmental and other conditions that change over time.

Age differences measured under resting conditions. In people, patterns of age differences appear in various physiological characteristics. Some are well maintained even in advanced old age. Others peak in middle life and then decrease. However, the most common pattern is gradual decline in adulthood.

Under resting conditions, many biochemical characteristics of the blood are well maintained even into advanced ages. There is no systematic change with age in glucose level, electrolyte content, acidity, protein level, total volume or osmolarity of the blood under resting conditions. This is not surprising since the life of each cell of the body depends on the stability of the internal environment. The various physiological mechanisms which regulate blood composition are capable of maintaining stable values even in advanced age if no extra demands are placed on the system.

Some physiological characteristics continue to increase after the attainment of maximum body size and sexual maturity, and are followed by decrements in late middle age and old age. For example, gastric acidity in the male continues to increase to a slight extent up to the age of 40. After this age there is a gradual decrement, so that at age 80 the average gastric acidity is about the same as the average at age 15. However, in females there is no continued rise during middle age. The maximum gastric acidity is reached by the age of 20 and remains uniform throughout life, so that by the age of 80 it is the same as for the 80-year-old male.

Average levels of blood cholesterol continue to rise until the age of 55 to 60. After this age there is a substantial decrement. Since these results were obtained from measurements made on different individuals at each age, it is often argued that the reduced values after age 55 are due to the mortality of individuals with high levels of cholesterol. Although this may be true for cross-sectional data, serial longitudinal measurements on the same subject also have shown a gradual reduction of cholesterol levels after age 55 to 60. This lowering of blood cholesterol levels represents an improvement of physiologic status. Incidentally, this finding shows the need for longitudinal study as a check on cross-sectional study.

The most common pattern of age differences in physiological characteristics is a gradual reduction in performance of many organ systems. Most show a gradual linear decrement that begins in the forties and continues throughout life. None of the average values shows discontinuities in the age regression with precipitous decrements following any given age.

Decrements in physiological functions are sometimes associated with increasing values for a specific measurement. For example, laboratory measurements have shown that the peripheral resistance in many vascular beds increases progressively with age. This increase in resistance requires more work by the heart in order to maintain the same flow of blood. There is also a small but significant increase in the average residual lung volume with age. Gas exchange in the lungs is therefore somewhat less effective in the old than in the young.

For some years, there has been substantial controversy about the relationship between blood pressure levels and age. This controversy has been resolved through the medium of several studies. There now seems to be no doubt that that there is a progressive rise in blood pressure levels with increasing age, particularly up to age 70.

Some of the physiological functions which decline with age when measured under resting conditions include: speed of conduction of the nerve impulse; cardiac output; renal blood flow and filtration rate; basal metabolism (when calculated on the basis of surface area); vital capacity; excretion of sex hormones; and thyroxine utilization.

Age differences in response to displacing stimuli. A primary effect of aging is a loss of reserve capacities in many organ systems. Many characteristics which show no age change in the resting state show significant differences in the degree of displacement and rate of recovery following a displacing stimulus.

The acidity of the blood under resting conditions is uniform throughout life, but the degree of displacement induced by the administration of acid or

alkali is greater in old people than in young, and the rate of return to equilibrium values is much slower. When glucose is administered intravenously, the old individual requires more time to bring his blood sugar level back to normal than does the young. Displacements in pulse rate and respiratory volume produced by standardized exercise are greater in the old than in the young and require a longer time for recovery.

Other organ systems also show a reduction in their response to stimulation. The responses of the adrenal gland to the administration of adrenocorticotropic hormone are reduced. Muscular strength and speed of motion diminishes in old age and both simple and complex reaction times are lengthened. The maximum breathing capacity is substantially reduced in the elderly. The ability to adjust to changes in environmental temperature is diminished.

Characteristically, older individuals are less effective than young in meeting the challenges of the environment and they require a longer time to readjust to their internal environment after displacements occur.

Variability in age changes. Clearly, age does not influence all organ systems to the same extent. We can state decrements in function as a percent of the mean value at age 30. Thus, for those between the ages of 60 to 90, we find that speed of conduction of nerve impulse declines by 10 to 15 percent. In high ranges are declines of as much as 50 to 60 percent for more complex functions such as maximum breathing capacity.

In general, age effects appear greater in functions requiring coordination of various organ systems than in the performance of a single organ. Also, greater age decrements in function occur under stress than under resting conditions.

Age does not have a uniform effect on different organ systems even in the same individual. Thus, a 75-year-old subject may have a cardiac output that is as good as that of the average 60-year-old, whereas his renal function may be that of the average 80-year-old. These differences in the rate of aging among organ systems represent the source of many of the medical and sociological problems of older people.

There are also wide individual differences in the effects of age on the whole person. Some 80-year-old subjects have a total physiological capacity as good as that of the average individual many years his junior. One primary research problem is to find out why some individuals retain physiological capacities so much longer than others. Individual variability also has special significance for the physician. It means that the elderly patient must be carefully assessed and dealt with as an individual and not as a member of any age group, since groupings based on chronological age are much less homogeneous in the old than in the young.

Mechanisms of loss of reserve capacities. The reduction in performance of an organ or organ system may be due either to a gradual loss of functional units or to a gradual impairment in the remaining units, or a combination of both. Nailing down that which applies to a given organ is difficult.

Physiological tests of a variety of renal functions show similar rates of age decrements. Hence, the losses in renal performance may be ascribed to a gradual loss of functioning nephrons. Histological evidence, which also shows a gradual loss of glomeruli in the kidney with advancing age, is in accord with this presumption.

Basal oxygen per square meter of surface area does show a gradual reduction with age. However, surface area is a poor estimate of the amount of functioning tissue in the individual. This is because surface area is calculated by measurements of height and weight. The weight of the individual includes not only the mass of functioning cells but also the amount of fat and other metabolically inert substances which have accumulated in the body.

Since the water content of the individual cells does not change appreciably with age, the intracellular water content of the body may be used as an index of the amount of protoplasm present. Total water content of the body can readily be estimated by dilution techniques with antipyrine, tritium labeled water, or deuterium. Extracellular water can be estimated in a similar manner by the injection of a known amount of sodium thiocyanate; the difference between total body water and extracellular water is an estimate of intracellular water.

Studies have shown that the basal oxygen uptake per liter of intracellular body water does not change significantly with age. Hence, it may be concluded that the decrement in basal metabolism is simply an expression of the loss of functioning cells.

There is also considerable histological evidence to show a gradual loss of cellular elements in muscle, brain, and nerves with increasing age. Thus, we must conclude that a part of the reduced functional capacity of the elderly is due to the gradual loss of cells from various organs of the body, especially in those tissues where cell division, and thus replacement, is absent or greatly reduced in the adult.

However, loss of functioning tissue, or of cells, will not explain all of the age decrements observed in human beings. For example, renal function and resting cardiac output fall at a greater rate than does total body water content. We must therefore look for some impairment in function in the cells remaining in the body. Enzyme activities of tissues and cells have been studied in such animal species as the rat. Many enzyme activities have failed to show age changes. But some, such as succinoxidase, show significant decrements in certain tissues, such as the heart and kidney. These decrements cannot be ascribed to tissue losses alone. It is probable that the general phenomenon of cell dysfunction is related to age changes in a variety of cellular processes. These factors will be discussed later in the section under cell changes.

UNDERLYING FACTORS

What is behind the physiological changes described in the previous section? Age changes may arise from two types of causes, intrinsic and extrinsic. The common denominator for intrinsic and extrinsic factors is that they decrease the ability of the organism to perform functions that may be necessary for staying alive.

Intrinsic factors occur inevitably, regardless of environment. They may be considered as a natural property of the organism, resulting from one or more of the processes and structures characteristic of living systems, in much the same sense as the eventual wearing out of an automobile engine is an intrinsic part of its nature and the result of continued "normal" operation.

Extrinsic factors are environmental influences. They may be modifiable to some extent, and they may have an immediate interest to practitioners. Extrinsic factors may be of different magnitude in different environments. They include such factors as radiation, temperature, physical injury, diet, and such agents as harmful bacteria and viruses. Psychological and sociological events, influenced by the individual's own emotional make-up, may modify his aging.

Intrinsic Factors

The ultimate basis of all intrinsic age changes as well as developmental processes lies in the genetics of living systems. The genes, which are located on the chromosomes and whose information (or directions) are coded as the nucleotide sequences of deoxyribonucleic acids (DNA), are the basic determiners of the biological properties of living beings. Four kinds of genetic effects have been suggested as possible contributors to aging processes:

(a) genes that cause rapid aging or decreased viability and low resistance to disease;
(b) genes that, though generally beneficial in early life, slowly produce harmful changes as by-products of their normal function;
(c) genes for longevity that have not appeared or evolved because they are inconsequential to species reproduction and survival;
(d) genes or gene products that are not accurately reproduced during development or that are accumulated as a result of so-called somatic mutation.

The complexity of living systems arose through evolution, that is, genetic variation and natural selection. The evolution of a species appears to depend on the senescence and death of individuals. In another way, too, senescence and death are provided for in nature. The second law of thermodynamics states that, with time, systems—biological or not—tend to become disordered.

If a living system (or any other system) is exposed merely to the passage of time, a number of changes will occur. Most of these changes result in a more disordered arrangement of the molecules and atoms of which the living being is constructed. Such an increase in disorder is referred to as an increase in the *entropy* of the system.

Some changes which take place very slowly, when compared with the time required to reach reproductive maturity, do not have an important selective disadvantage, and for this reason are not eliminated in the evolutionary process.

Therefore it is evident that some deterioration will occur in all living systems and *in all likelihood aging is the sum total of those naturally-occurring*

increases in disorder for which evolutionary selection has not produced an effective counteractant.

Let us examine briefly the nature of some of these changes and where they occur.

Molecular disorder. At the molecular level the second law of thermodynamics says that weak chemical bonds will, on the average, tend to be broken and strong chemical bonds will tend to be formed. The regular function of molecules of living things depends upon the proper arrangement of atoms involving both weak *and* strong bonds. Any atomic change will decrease the functional capacity of the molecules in question.

So, too, with the arrangement of molecules; if a given molecule can exist in any of two or more configurations and one of them is more stable (more probable) than the other, there will be a transition from the unstable to the stable arrangement.

Three kinds of molecular changes in addition to the random formation of new bonds within a molecule will be considered. The first of these is denaturation. The structure and normal function of many proteins is dependent upon their possessing a specific shape. This shape is maintained by the formation of very numerous but weak (hydrogen) bonds between different parts of the amino acid (polypeptide) chains which make up proteins. If these stabilizing bonds are broken as a result of an accidental (statistically improbable) concentration of heat energy in the vicinity of a protein molecule, the molecule is likely to be transformed into another shape which no longer possesses biological activity. Such changes can be produced at will in the laboratory. A common example is the denaturation of "native" albumins in an egg on the breakfast skillet.

The second type of change involves the associations between protein molecules or other molecules. Proteins possess electrical charges; they tend to associate with each other in a web-like matrix but usually are prevented from doing so by anti-gelatin agents or by repulsion forces. Once an association has been formed between two protein molecules, however, the chances of the molecules becoming dissociated again may be quite small. With time, more and more molecules may be added to the network fabric. Such an accumulation of intracellular "gel" will act as a barrier to free diffusion of other molecules important in the vital function of the cell and thus may decrease life function.

The third molecular change which may contribute to aging is the formation of linkages between various molecules within cells. This process is referred to as cross-linkage, and is similar to the tanning of leather to make it more resistant and durable. Of particular importance in the formation of cross-linkages are reactive groups in fatty substances, particularly (unsaturated) double bonds. Such double bonds are slowly attacked by molecular oxygen from the atmosphere and yield points of great chemical reactivity which can form stable bonds with other molecules in the environment. The consequences of such processes include the removal of cross-linked molecules from active participation in the life of the cell and the blockage of free movement (diffusion) of other molecules. Both of these processes would reduce the maximum work capacity of cells thus affected.

Cellular structure and changes. Among theories bearing on causes for aging are those concerned with the cell as the basic target. These theories may be classified into three groups: the exhaustion theory, the error theory, and the eversion theory.

The exhaustion theory depends upon the intracellular accumulation of deleterious substances and the rate of cellular metabolic activity as affected by such factors as temperature, nutrition, and oxygen consumption.

Examples of the error theory include errors in DNA with cellular mutations, errors in RNA messages resulting in wrong protein synthesis and enzyme action, and inadequate cell division for replacements.

The eversion theory depends upon the influence of metabolic by-products in increasing cross-linkages between connective tissue molecules, particularly collagen.

The molecular processes referred to above may reflect themselves in physically observable changes at the cellular level. For example, there may be a loss of certain kinds of organized structures (such as mitochondria responsible for energy production or endoplasmic reticulum that are sites of protein formation) in cells as well as changes in their architecture or efficiency. For example, changes recently have been observed in the amount of ribosomal material attached to the delicate network of endoplas-

mic reticulum in old rotifers as contrasted with the young.

The nucleus of the cell as well as the cytoplasm is not immune to the disruptive influences of time and entropy. With the passage of time, it has been suggested that changes in the genetic code of individual cells occur on a random basis. This is referred to as somatic mutation. Moreover, when cells divide, accidental losses or changes in the amount or kind of chromosomal material may occur. This has been documented very nicely in the liver of the laboratory rat. It has been shown that old rats possess more chromosomal abnormalities than do young rats. While showing that changes in chromosomes do take place in certain cells during aging, concomitant findings indicate that these changes cannot be *the* major cause of aging. Many more mutations may be induced (using X-rays) in young animals than appear in aged animals naturally. Yet, this mutation load in the X-rayed animals has no significant life-shortening effect. Thus, the meaning of the chromosomal abnormalities to aging remains to be explained.

A final change within the cell is the accumulation of pigmented inclusion bodies in a variety of different kinds of mammalian tissues, including muscle and nerve cells. This so-called age pigment appears to be an insoluble complex of proteins and lipids which have been altered as a result of reaction with molecular oxygen. This material is highly insoluble both in organic and inorganic solvents, is brightly fluorescent, and has an absorption spectrum (color) similar to that of lipid substances which have been exposed to oxygen at room temperature in the laboratory. The amount of these substances is believed to increase in a linear fashion in the human heart at the rate of about 1/2 to 1 percent of the intracellular volume per decade. Thus, in a 100-year-old individual, pigment may occupy as much as 5 to 10 percent of the interior of the cell. In the nerve cell such a condition may not exist or may be very markedly influenced by environmental conditions. Quantitative measurements are yet to be made in nervous tissue.

Few observations of structural changes in cells are universally accepted as clear evidence of intrinsic age change, and therefore there is much disagreement among investigators.

Let's consider two types of cells:

The post-fixed mitotics: those that reach a degree of specialization and do not undergo division. For instance, nerve cells generally last the lifespan of the organism.

The intermitotic cells: undifferentiated, such as the basal cell of the epidermis; and differentiated, such as the hepatic cell. Intermitotic cells are capable of division, and age of individual cells is unknown.

Post-fixed mitotics. Changes in nerve cells with age are often in dispute. Unusual forms of *mitochondria* observed in old animals are observed also in young animals. The size and shape appear related to the functional state of the cell, rather than related to its age.

Many of the Golgi complexes in neurons of senile animals are altered. Paired membranes form large vacuoles, vesicles increase in size, and membraneous appearance is lost. These changes are considered as possibly due to aging.

Although increasing pigmentation of nerve cells generally is associated with aging, it is not yet a proven age change.

Several investigations indicate that ribonucleic acid may decrease with age, but other studies do not confirm this.

Changes in lysosomes and cytoplasmic membranes with aging remain to be confirmed. Alterations in the shape of the nucleus have been attributed to senescence but occur as well in young animals and in diseased states.

Intermitotic cells. The structure of cells in many intermitotic tissues alters readily with changes in nutrition, temperature, endocrine and exocrine secretion, and even exposure to sun. Again, relationships of changes to aging often are uncertain.

Spleen of senile rats shows loss of follicular tissue and loss of demarcation between red and white pulp. Changes in myeloid tissue (bone marrow) are regarded as conjectural. Some increase in plasma cells has been reported with aging.

No definite evidence of age changes appears in smooth muscle or male sex gland cells. Adrenal tissue becomes more fibrous, pigmented, and nodular with age. Liver cells become more pigmented, have giant nuclei, and greater nucleo-cytoplasmic ratio, according to some observers.

Enzyme changes. We know that loss of cells occurs with age. We also know of age-dependent

alterations in the activities of specific enzymes within cells that remain. Unfortunately, these data do not confirm any one of a number of biochemical theories of aging. Nevertheless, selected enzymatic decrements can be offered to explain age-associated declines in some physiological performances.

A cell has two general functions:

1. To support the whole organism.
2. To support itself.

These functions depend on the cell's ability to produce and utilize energy in synthesizing essential molecules. The governors of synthesis are enzymes. Many reactions occur, each regulated by a specific enzyme.

Varied results and interpretations have come from studies on enzymatic activities and aging. For example, the lactic dehydrogenase activity of the human aorta increases per unit of tissue nitrogen from birth to middle age and then decreases. This pattern occurs also with the enzyme arginase in rat liver, acid phosphatase in mouse liver, cholinesterase in human and female-rat plasma, and succinic dehydrogenase and cytochrome C oxidase in rat kidney.

However, other enzymes show a different pattern —increased activity during the growth period after which there is relatively little change. This is the case for cholinesterase in honey bee brain and of succinoxidase in rat liver. A third pattern is shown by acid phosphatase in rat liver in which there is activity through the lifespan. A fourth pattern is shown by the catheptic activity in rat liver, which increases during senescence.

In general, the most striking changes in enzymatic activities occur in early life. Senescence is not accompanied by any uniform change. Thus, it has not been possible to formulate any general hypothesis about the relationship of changes in enzymatic activities to age, even though selected enzymes do show specific age-associated changes.

A current theory proposes that senescence is associated with alterations of deoxyribonucleic acid in the nucleus. DNA, through its messenger RNA, is the progenitor of enzymes and other proteins. A defect or error in DNA may render an enzyme useless or only partially effective in processing nutrients or substrates. These accumulate, and the accumulation provokes the chain of events that ordinarily produces effective enzymes. Some investigations have detected more messenger RNA in old rat liver cells than in young ones, lending some weight to the so-called "error hypothesis."

As has been stated, there is good evidence that a loss of cells occurs with aging of many tissues. However, the picture is complicated in an attempt to relate the number of cells to performance of a single organ in the living animal. In the rat, senescence is accompanied by a 50-percent reduction in urine osmolarity, which gives an estimate of kidney function. However, the kidneys of these animals had an estimated 10-percent loss of cells with age. Thus, cellular loss alone could not account for the decline in performance. Possibly the discrepancy may be accounted for by loss of mitochondria and changes in specific enzymatic activities.

Cell death. Two kinds of cell death occur in aging organisms. The first kind may be called developmental death and occurs in structures such as the skin, the blood, and the lining of the digestive system as a natural part of the normal functioning of these organs. The production of new cells to take the place of those which have died almost exactly compensates for them. Thus, it is not generally believed at present that developmental or normal cell death is an important causative factor in the aging process. It is quite likely, in fact, that organs and tissues in which a regular replacement of cells takes place do not contribute substantially to the aging process. Rather, aging is primarily a property of those cells and systems in which there is no evolved mechanism for regular replacement either because such cells are well shielded from the environment or because they have a long natural lifetime. Indeed, more probably it may be a function of the degree of their specialization.

Information on cell death or cell loss in nondividing tissues and organs is as yet established in only a few cell types. It has been shown that the number of large Purkinje cells of the cerebellum, the number of cells in certain spinal ganglia, and the number of axons in certain nerve tracks decrease slowly with time to about 60 to 80 percent of their value in young persons. There is also a decrease in muscle mass of most aging animals. Whether this is due to a decrease in the size of individual muscle cells or to loss of numbers of cells has not been demonstrated conclusively as yet.

Tissue rearrangement. In addition to the loss

of cells which occurs with time, there is also a change in the relative positions of cells. This can be seen clearly when one compares the microscopic appearance of young and old tissues. With the exception of age pigments, which also serve as an index of aging in many cell types, this increased irregularity in the arrangement of cells is one of the few available clues we have regarding the age of the animal from which the tissue section was taken. The appearance of the fibrous proteins and loss of cell elements are other indications. The quantitative measurement of the irregularity of cell arrangement has not yet been undertaken.

Extracellular changes. During aging, certain changes also take place in the medium surrounding the cells. Space between the individual cells and the blood vessels is occupied by fluids, by various kinds of fibers which bind the tissue together into a coherent mass, and by jelly-like coatings on the major surfaces (mucopolysaccharides). Investigation has shown there is gradual increase in the amount of insoluble collagen relative to mucopolysaccharide content of tissues. Even the kinds of mucopolysaccharides change during growth and possibly during senescence, but the true physiological meaning of all this is not clear.

Changes in collagen during development and aging have been demonstrated both in the rat and in the human. But the major changes which have been observed occur during the developmental period prior to sexual maturity and may be regarded largely as maturation rather than aging. The changes appear to consist mainly of cross-linkages between and among adjacent collagen molecules. This collateral binding results both in a decrease in the solubility of the collagen and in a change in its resistance to thermal disruption.

Physical chemists believe that crosslinking, or biochemical vulcanization, maintains the essential properties of fibrous connective tissue. However, uncontrolled propagation or accumulation may lead to degeneration because the effect of crosslinked collagen on diffusion of materials intercellularly may lead to slow death of cells. While atherosclerosis may be a probable cause of aging in many organs by way of reducing blood supply, the effect of crosslinking on diffusion of nutrients from blood vessels to cells may be more fundamental.

Changes in collagen and other tissue influence the morphology and composition of skin, vasculature and joints.

In general, skin seems to become less stretchable and less contractile with age. There is a tendency for fibrous elements to become altered with aging, although chemical analyses fail to show unequivocal quantitative changes in collagen or elastin.

Indentation and compressibility, or folding, of human skin generally diminish with age, but unexposed areas of the body do not follow this tendency. Actinic rays of the sun interact with collagen fibers of the skin connective tissue, and degrade them into rubbery substances. Hence, the face of an older person has wrinkles, but the abdomen is smooth.

Another age-associated observation has to do with healing. Ordinarily, newly-synthesized collagen fibers arrange themselves into a plywood-stacking fabric. Each fibril grows in diameter as it accepts new collagen from active cells. In the aged, as seen in rat tail tendon, fibrils tend to be of the larger sizes. Thus, even though chemical concentration may not change significantly with age, the morphology of fibrous connective tissue does change.

The body's vasculature is part of a system that gives high elastic impulse to ejecting blood. The thoracic aorta has a higher elastin content than abdominal and femoral vessels, which have more collagen. The system's requirements of strength and reinforcement are satisfied in the lower vessels by collagen fibers, which limit extensibility.

With age, the stretchability of arterial tissue diminishes. The stretchable length of fibers diminishes, and the result is a loss of elasticity at high pressure. In addition, cholesterol reduces the amount of elastic fibers. These alterations reduce the body's capacity to move blood.

The picture is different in the heart. Size of cardiac myofibrils and the amount of elastic tissue increases with aging. Replacement of collagen by elastic tissue also is seen, perhaps interfering with cardiac output.

As already stated, there is a reduction of muscle mass in many aged animals. Their inability to maintain high muscular activity may be a reflection of this in addition to alterations in neural control, rate of chemical reactions, and reduction of blood supply. In uterine muscle, connective tissue increases and collagen becomes tougher in the aged.

As joints age, the water-absorbing capability of tendons decreases and collagen fibers aggregate into

larger bundles. Both changes make joint connective tissue stiff. Another cause of stiffness is change in the structure of articulating surfaces of joints, attributable to change of composition of cartilage as well as its water content. Welding together of cartilage surfaces during periods of inactivity adds to stiffness, and lowering of temperature around finger joints accentuates it.

Integrative changes. There is a gradual decrease in the amount of certain hormones and of the activity of various glandular systems with age. In particular, a variety of sex hormones have been shown to be decreased in their production as human beings age. It is difficult, if not impossible, at present to evaluate the effect of these changes on the overall performance of animals. Some improvement in various functions has been noted as a result of the injection of specific hormones. But does this therapy actually repair the machinery of the body or simply tune-up the equipment which remains? We do not know.

Extrinsic Factors

Nearly every environmental factor can influence the health, physical condition, and length of life of organisms, but certain of them are more important than others.

Temperature. Among the most thoroughly studied of factors which can affect the length of life of cold-blooded animals is environmental temperature. This fact was first examined near the turn of the century, and again more recently. The recent studies indicate the rate of aging is affected by temperature to about the same extent as is metabolic activity. It does not appear likely, moreover, at least in the case of the common fruit fly (Drosophila melanogaster), that the accelerated loss of function at high temperatures is due to protein denaturation, for this process increases much more rapidly as temperature is increased than does the lifespan.

Mechanical forces. A second environmental factor contributing to age changes is simply the dissipation of physical energy on the organism through bumps, bruises, breaks, abrasions, etc. Since most of these injuries are to the outer surface of the body, the reparative processes restore the original condition of the organism except for scars. It is unlikely that physical injuries are an important contributory factor to the debilities of age except in a small percentage of the population.

Radiation. Both mutagenic high energy ionizing radiation such as X-rays or cosmic rays and the invisible ultraviolet light to which animals are exposed may cause mild to severe changes. Ionizing radiation is probably not a serious contributor to aging in a normal environment, but animals which have been exposed to 200 to 500 roentgens show cell loss and changes, particularly in the circulatory system. Fibrosis of small arterioles has been observed. These changes are in some respects similar to the changes which occur during aging.

Long-continued exposure to ultraviolet light produces injury to the skin affecting not only the cells which give rise to the continually replacing epidermis but also may cause the alteration of the collagen layer underlying the surface layers of the skin and its replacement by elastin. This condition is referred to as solar elastosis and expresses itself as the familiar wrinkling due to the change in elasticity which is characteristic of old skin, particularly on the exposed surfaces of the body.

Toxic substances. A number of substances naturally occurring in living things in appreciable concentrations may very adversely affect the chances for life. Many of the effects of bacteria are due to the poisonous substances that they create and liberate into the blood stream. For example, the toxins liberated by diphtheria bacteria or streptococci may cause changes in the cells or tissues far removed from the initial site of the infection.

Air pollutants, tobacco smoke, and certain substances normally taken as food also may have a chronic toxic effect. Some pesticides and other compounds containing selenium, mercury, lead or arsenic incorporated into the food have been shown to produce pathological changes in people or animals. Ingested radioactive isotopes also have produced changes similar to those produced by exposing animals to external sources of ionizing radiation. In a recent study it has been shown that heavy water in concentrations of 20 percent to 30 percent will considerably increase the longevity of the fruit fly *Drosophila*. Whether this effect is due to a slowing down of the aging process has not been settled.

Diet. Probably the most important chemical factor affecting longevity is the nature of the diet. The effect of diet may be either towards a shortening or a lengthening of life. Thus complete elimination of an absolutely necessary factor from the diet or a caloric intake unequal to the minimum needs of an animal may kill the animal, and thereby shorten his lifespan. According to some of the early studies, substantial dietary restriction of young animals will nearly double their lifespans; too much food will shorten life by taxing certain organ systems, fostering specific diseases such as atherosclerosis.

To amplify: the omission from the diet of any essential nutrient such as a vitamin or an essential amino acid will result in malfunction. Chronic or periodic undernutrition may be an important cause of aging in populations in certain areas of the world. In most western countries, however, undernutrition has been supplanted by overnutrition. High fat content diets apparently have caused an increase in certain kinds of age-associated pathologies, particularly in atherosclerosis, which reflect themselves in the incidence of heart disease and cerebral vascular accidents. It is interesting that the incidence of heart disease, coronary attacks, etc., in Europe was extremely low during the war years when the food supply was very limited. The incidence increased enormously during the post-war prosperity.

Insurance statistics clearly indicate a strong inverse correlation between overweight, even to a mild degree, and lifespan. The development of a new set of dietary habits would probably do much to alleviate this source of age change.

Social Milieu. The activities of other living forms, including human beings, are extremely important in determining the rate of extrinsic age changes. The habits which the individual acquires from his parents in such matters as cleanliness, rest, and general psychological outlook play an extremely important role in his ability to preserve his physical integrity as he ages. The importance of social milieu is shown by statistics on the longevity of British army personnel in peace time as compared to the total population. According to one study, the mortality rate of such individuals was more than 4 times as great as in the population at large. Similarly, the use of tobacco, in large part culturally determined, increases the probability of death at any given age.

The use of alcohol in "moderate" quantities does not seem to appreciably affect longevity. In fact, one study showed that the moderate group had a better life expectancy than the total abstainers taken as a whole. Extreme alcoholism leads to many deteriorative changes; the liver, for example, may become hardened through the double processes of cell loss and replacement of normal cells by collagenous connective tissue. Such diseases are extremely rare in the Jewish population because of the cultural strictures against excessive use of alcohol.

Microbes. Probably the most important biological factors affecting lifespan are the microbial and viral pathogens which cause disease. The remarkable increase in the average lifespan which has occurred in the last 40 years is in large measure due to the improvement in hygiene and in the development of effective antibiotics and immunization. It is interesting to note that the factors responsible for early mortality in the laboratory rat are frequently of bacterial or viral origin and one can, as in the case of human beings, greatly increase the average life duration of rats by keeping them free of such pathogenic infections.

Possibilities. Certain possibilities exist for retarding, but probably not for abolishing, the effects of time and environment. The effects of various disruptive environmental factors already have been reduced by public health measures, information on diets, promotion of safety practices, and other measures.

Better diet and hygiene as well as prevention and treatment of new growth and degenerative diseases will, no doubt, further postpone the mean age of death. Nonetheless, senescence and death are ultimate inescapable consequences of human biology.

Possible means of postponing or counteracting these effects may exist in: the experimental reduction of body temperature to a value allowing efficient function (e.g., 33–34° C.); the discovery of special chemical substances to promote the growth or division of cells that normally limit the function of old organisms; the development of agents to reduce the rate of formation of cross linkages in proteins; and the development of *in vitro* or *in vivo* techniques for the replacement of worn-out organs or their parts.

The whole field of organ and tissue transplantation opens wide vistas. This subject is quite obviously beyond the scope of this monograph, but it does seem fitting to indicate its potential importance in considerations of the aging organism. The possibility is great that human aging and longevity may be enormously affected by these revolutionary concepts and technical advances made in this area; however, the limits at this point in time seem difficult to anticipate.

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PSYCHOLOGICAL ASPECTS OF AGING

From early development through old age, man is subjected to a complex variety of influences, both internal and external, that add up to the process we call aging. Basically, these influences can be broken down into three main categories: biological, psychological, and sociological.

An individual's biological age can be regarded as his position in time relative to his potential lifespan. Since the mortality rate accelerates with age, chronological age is a crude index to the probable length of life the individual has remaining, that is, his biological age. Biological age may also refer to the efficiency of the physiological functioning of such major organ systems as the cardiovascular, respiratory, or nervous system.

Psychological age refers to the individual's capacity for adapting to his environment. This would include such things as sensory functions and perception, memory and learning, thinking and problem solving, motor skills, motivation, attitudes, personality, and factors of mood and morale to sustain adaptation and productivity.

An individual's social age refers to his roles in the family, at work, in his community, as well as his interests and activities. Society has graded behavior patterns in such a way that they are age-related. Thus an individual's social roles or behavior may be seen as being young or old for what might be expected from someone of his chronological age.

Biological, psychological, and social age are interdependent, but only partly so. There is no single *process* of aging which accounts for all the changes in man as he grows old. Research suggests these are *processes* of aging. One should speak therefore of the biological processes of aging, the psychological processes of aging, and the sociological processes of aging. The importance of any particular process will vary with the particular phenomenon of aging one is trying to explain.

Psychological aging seems to have a greater unity than in fact it may have from a scientific standpoint. One reason is that we are aware of our own progress in time. Having an intimate knowledge of our own personal history leads us to believe there is more order to the sequence of events in our lives than would be perceived by an external observer. While our personal or subjective estimates of our aging are important, we may be oblivious to changes in ourselves that are apparent to others.

To deal rationally with the problems associated with advancing age, it must be kept in mind that, like the child, the adult is always changing and evolving. He is continually undergoing changes of a biological, psychological, and social nature, never reaching an unchanging plateau. At the attainment of the legal age of 21, the individual has lived, on the average, only about 30 percent of his lifespan. The 50 years to follow embrace the psychology of aging.

Developmental tasks. Adult life is a process of continual change, as the individual is faced with new tasks that require him to adapt to new circumstances. While these tasks are unique to the individual, they do form a pattern that can be described as the developmental tasks of the life cycle. Each task is associated with a certain amount of "role uncertainty," whether it occurs in the twenties or in the eighties. Courtship, marriage, childbirth, career changes, changes of residence, retirement, and death of peers and spouse are among the elements that form important parts of the content of the adult life. Changes in appearance, body function, and health

also present problems or tasks to which the individual must adapt.

Throughout the adult lifespan, the individual's capacities to solve problems and adapt will be challenged by situations that may be novel to him but are characteristic of his age level. Should the individual undergo a reduction in his capacity for adaptation, even though a task is characteristic of a specific age level, the reaction to it may constitute a crisis or an emotional problem. However, adequate adaptation to earlier problems increases the likelihood that he will be able to cope with the tasks unique to later life.

Uncertainty of role. We have become sensitive to the uncertainties that arise at characteristic points in childhood; however, we are just beginning to be aware of the uncertainties that arise when adults change roles. The uncertainties of pubescence in a girl may have a counterpart in the changes of appearance in the middle-aged woman. The elderly grandfather may be as uncertain about how to act toward his young grandchild as the grandchild is uncertain about how to behave in the presence of his grandfather. Similar role uncertainty is seen in the remarriage of elderly parents. Uncertainty can be seen in the parents' relationships with their married children. The resolution of such uncertainties in social role will depend upon the present adaptive capacities of the individuals and their earlier life habits.

Social change. Not only do we as individuals change with age, but there are also trends in society that often render our models of age-appropriate behavior out of date. Present trends for early marriage and child rearing result in an "empty nest" period for middle-aged persons when the last child has grown and left the home. Around 1900, the average marriage dissolved through the death of one of the partners before the last child was married. Now, about 15 years of married life together may be expected after the last child marries. This means that there is a long period of family life together after the children leave the home.

The lack of social roles and models in our society for such "pre-retirement" living results in uncertainties about family life. Further uncertainties result from the fact that one way of adapting to the empty nest is for the woman to take a job in middle-age. New psychological issues emerge when the woman moves out of the house into a job at a time when her husband's career has probably stabilized and perhaps become boring. Such events can be mid-life turning points for marriages when some improve and others decline in satisfaction for the partners.

Our attitudes towards the appropriate content of family life are complicated because we are in a period of rapid social change. For example, earlier periods of history did not have a large proportion of widows in society. Increasingly, women are living longer than men and they are gaining more than men in life expectancy. More than 50 percent of the women over 65 are widows, whereas only 22 percent of the men over that age are widowers.

These are but a few indications that not only do individuals change biologically during their lifetime but they also change psychologically, since they are constantly required to adapt to a changing physical and social environment. Nonetheless, despite great social change, adult life maintains a characteristic rhythm. Certain concerns and moods are associated with certain episodes in the adult lifespan. Middle-aged persons show more sensitivity to problems of health in themselves and friends. An aged adult tends to attach great importance to his immediate physical environment and his attitude toward a household move contrasts with the easy residential mobility of the younger adult. Such events as moving of place of residence can be turning points in the psychological and social life of the older individual and can precipitate health problems or exacerbate previously existing health conditions.

DETERMINANTS OF AGING

We have grown used to the idea that the individual's heredity plays a role in how long he is likely to live. Less commonly considered is the fact that the individual's psychological and social environments also influence the length as well as the quality of his life. Indeed, at the present time in our society an individual's probable length of life is related more closely to his social environmental background —i.e., sanitation, preventive health care, and accident prevention—than it is to the longevity of his parents and grandparents.

The particular environment in which the individual grows up and grows old determines to a consid-

erable extent how he will express his genetic potentials. As society becomes more supportive of individuals physically, socially, and psychologically, however, then differences in genetic background probably will become more important and eventually dominate longevity and aging.

Relatively high education and greater awareness of principles of health care are typical of middle-class people. Also, the higher the socioeconomic class, the greater is the individual's desire for personal services. Research has shown, for example, that poor health lowers the morale of individuals in the lower socioeconomic group more than it does in a high socioeconomic group. The consequences of problems of ill health are magnified by a combination of disease, low economic status, and social isolation. In such a context, elderly widows not only represent a population with great need for health services but also a population in which strong psychological and sociological factors influence the likelihood of seeking treatment and magnify the consequences of illness for the morale of the individual.

Regional differences in rates of rejection for the military draft also suggest important socioeconomic influences upon health and behavioral capacities. Variations in climate, for example, are much smaller in their effect on the occurrence of diseases of the circulatory system than are socioeconomic influences. Families that strive up the socioeconomic scale are much more likely to seek professional attention for mental health and other problems than families that are less achievement oriented. In general, behavior associated with the lowest socioeconomic class is dominated by struggles for simple subsistence. Individuals from the middle socioeconomic class, more achievement-oriented, tend to be in a more adequate stream of information leading them to seek professional services and to have higher personal standards and expectations. Different streams of information influence perceptions of physical health, standards of well-being, and the awareness of steps to be taken for the improvement of any limitation of function.

The nervous system. Several features of the nervous system warrant emphasis in any discussion of aging. The nervous system is a pathway by which environmental factors have health consequences. The nervous system is unique in having an organization stemming from the genetic background of the species but shaped by the unique experiences of the individual.

Cells that do not divide—fundamental in the nervous system and elsewhere—may be most important in aging. In particular, the cells of the nervous system are critical in influencing functions of the body. As old as the individual, neurons, through their role in integrating functions of the body, are able to spread the effects of age changes to other organ systems and remote tissues. Individuals who escape cardiovascular disease and neoplasms may show senescent changes that are heavily influenced by the aging nervous system. Biological changes of the nervous system underlie deterioration of behavioral capacities and health. Evidence also suggests that important restrictions and other changes in the activity patterns of the individual will produce a chain of crises. Serious, if not terminal, illnesses may be precipitated. For instance, the aging individual whose loss of coordination leads to recurrent falls may surrender his roles in community activities, stay home, become depressed, lose appetite, and become vulnerable to infection.

PERCEPTION

In most sensory systems, acuity declines with advancing age. Reduction can be a consequence of age-related diseases and occupational injuries, as well as changes in the receptors that may be due to primary aging.

From age 20 to age 60, the rate of hearing impairments rises from about 10 to about 75 per 1000 population. However, between ages 60 and 80, the rate accelerates to 250. Thus, 1 out of 4 very aged persons has a significant hearing impairment. In the same age group, about 80 individuals per 1000 population are blind.

Not only does the proportion of persons with sensory defects increase with age, but there is a significant acceleration of this increase past the age of 60. Commonly, therefore, the individual over 60 must adapt to some type of sensory change that reduces the amount of information he receives from his environment. The viscera and the proprioceptors as well as organs of touch, smell, taste, hearing, and seeing provide reduced information on which to base his behavior.

With age, most sensory receptors require more energy to reach a threshhold level of stimulation.

Turning up the lights or the radio may annoy younger companions but this is an adaptation by the older adult to increase his sensory input.

One consequence of the reduced sensory input is the need to become more conscious of behavior, to monitor and recheck sensory input before making some movement. Crossing the street may be slow and uncertain for an older person, not only because of the necessity to judge the automobiles and the traffic lights, but also because of the necessity to monitor foot movements. Some evidence suggests that older persons have to monitor their body movements visually in order to secure adequate placement. Because previously automatic movements of walking or eating need to be watched, the aged reduce their attention to the environment.

In general, the sensory changes associated with advancing age effectively reduce alertness. Compensations for sensory losses are achieved in part through closer monitoring, increased intensity of stimuli, and slowness and cautiousness.

To some extent, losses in acuity can be explained by changes in a peripheral sense organ. In the eye, for example, small opacities, by diffusing the light, may result in increased sensitivity to glare. The retina itself may show changes in receptor elements. Beyond the peripheral sensing structures, however, there may be inadequate central interpretation of the incoming information. In a small proportion of older individuals, compensating for sensory "fading" is not easy. Raising the level of sensory stimulation, such as intensity of sound or brightness of light, will not automatically result in increased perception or resolution of the problem concerned with sensory input. Hearing aids, for example, raise the sound level of incoming signals but do not always result in improvement in speech perception. The focal issue is the capacity or "resolving power" of the central nervous system to handle the information reaching it via the sensory system. Older individuals often have to be evaluated with regard to sensory acuity and "central resolving power."

Thus, there is not necessarily a direct relationship between sensory acuity and effective behavior in the aged. Older adults, however, will tend to adapt to their sensory limitations and avoid stress situations. For example, older drivers avoid night driving because of relative insensitivity to light and susceptibility to the effects of glare.

Two simultaneous factors probably result in the aging individual's requiring more time to respond to stimuli. On the one hand, he generally requires more time to receive the same amount of information from his environment. On the other hand, he is also more cautious; he knows that errors made in walking up steps and crossing streets subject him to increased risks. Older persons, therefore, want and need more information from their environment before responding. It is possible that reduced sensory acuity lowers the whole level of excitation imparted to the nervous system and thereby tends to reduce the level of activity of the older individual. Emphasis has to be placed not only on the age changes in the peripheral sensory structures but also on the central integrating role of the nervous system. Although the most thoroughly studied of the sensory systems are hearing and vision, increasing evidence on touch, smell, and taste indicates that these senses also become less sensitive with age.

MOTOR PERFORMANCE

It was suggested earlier that one cause of the cautious voluntary movements of the aged stems from changes in sensory acuity. Many skills that improve with practice, such as walking, riding, or playing a musical instrument, may cease to have the automatic quality they had in earlier years. Movements never involve just one muscle. However simple a skill may appear to be, it is, nevertheless, a complex chain of events integrated by the nervous system. These patterns of finely coordinated voluntary movements involve continuous excitation and inhibition of neural activity. The resulting muscle movements comprise a graded distribution of sequential activity. Hence, if there are delays or reductions in sensory information about a limb position or the contracted state of a muscle, smoothness or speed of the voluntary activity is disrupted.

It is very likely that changes in motor skills in persons over 65 contribute to high accident rates. In individuals over the age of 65, accidents are the sixth largest cause of death. Deaths resulting from falls are more common than deaths from all other sources of accidents combined. Most of the fatal accidents in persons over 65 occur at home, thus ruling out the inexperience or unfamiliarity which might contribute to industrial accidents.

Subtle physical changes are believed to predispose the individual to accidents. Individuals who

repeatedly fall appear even at the outset to be less physically fit than those who don't fall. Physical education instructors believe that the aged who maintain a high level of physical activity have better control over their body movements. However, individuals who are undergoing certain of the degenerative diseases may constitute distinct subgroups of the aging. For them, sustained gymnastics designed to result in greater agility and the avoidance of accidents can be expected to have a less favorable effect.

Besides, the individual's judgment, in addition to perception and motor skill, can expose him to conditions beyond his physical or physiological limitations. Errors of judgment rank high in automobile accidents of older drivers. In young drivers, speed is a primary contributor to accidents, but drivers over 65 are less likely to drive fast than they are to misjudge speed or improperly manipulate their cars on the road.

Occupational accidents. Automobile accident rates do not parallel those for industrial accidents. Generally speaking, automobile accident rates decline from a peak around age 20 to a low about age 30. This rate persists to about age 55 and then rises. Industrial injuries, on the other hand, are lowest for workers over 65. One important reason for the difference may be the fact that industry tends to exclude individuals of advanced years and with health defects or other problems. Only the best and most experienced workers remain on the job after the age of 60 or 65. After age 35 men tend to be stable in their jobs. Being more skilled and interested in holding their jobs, they tend to avoid the impulsive acts characteristic of younger workers. Their experience leads to better management in the avoidance of accidents.

Athletic performance. Do relationships of age and performance in athletes tell us much about inherent physical changes and aging in general? First of all, it must be realized that athletic champions are peak performers. Rarely in daily life is the individual pushed to the limits of his physical capacities. In industry, individuals rarely work at their peak of speed, strength, endurance, and precision. Generally, the ability to respond to unexpected stimuli with strong, rapid, and accurate movements peaks early in life. On the other hand, there is a peak in mid-life for performance involving skilled movements that can be self-paced in response to familiar stimuli. Thus, professional boxers tend to reach peak performance earlier than do championship golfers or bowlers. The years of championship performance are different from those of years of enjoyment. In the new generation of older persons now emerging, early-life strenuous activities—such as tennis, long-distance swimming and running, and other "heavy" sports—persist as fun.

Research on motor skills tells us that demands on strength may be less embarrassing to the older individual than the pressure of deadlines. Older workers tend to drift away from jobs that are highly time-paced and involve response to rapid incoming signals. This suggests that adaptation to jobs requiring muscular strength is easier than adaptation to jobs in which the pressure of time is an important factor.

MEMORY AND LEARNING

Memory and learning are primary functions of the central nervous system. Our ability to adapt to a changing environment is, to a significant extent, dependent upon our ability to register, retain, and recall experience. Learning may be defined as the relatively permanent modification of behavior as the result of experience. Under most circumstances, age-related changes in the primary ability to learn appear to be small, even when sensory acuity begins to decline. When differences in the ability to learn do appear between individuals in their thirties and in their fifties, these differences seem to be attributable to problems of getting information into the nervous system, and to perception, control of attention, and motivation. Also relevant is general health, especially absence of diseases that might lead to impaired function of the central nervous system. Such factors are to be distinguished from a primary age-related change in the ability to learn.

When there is impairment in learning, one should not infer that some typical process of aging is at work. Rather, one should suspect either some prior incapacity or debilitating change in the individual. Evidence showing an age difference in learning is based mostly on comparing individuals over the age of 65 with individuals in their twenties.

A distinction must be noted between functions of the central nervous system that involve learning

of meaningful tasks and those that involve conditioning of reflexes. In conditioned-reflex (psychophysiological) experiments, it is sometimes more difficult to elicit a response in the older than in the younger subject, such as an eye blink, a change in skin resistance, or a voluntary withdrawal to electric shock. Possibly the autonomic nervous system has a change in arousal with advancing age. Apparently the intensity and duration of physiological arousal during a learning task are different in older individuals and influence the acquisition or extinction of responses. To repeat, deficits in learning are more likely to be due to an associated variable in the aging person (such as arousal) rather than to intrinsic changes in the ability to learn.

Interference. When old and young subjects have been given a chance to learn the same tasks, they tend to show no difference in overcoming interference effects when tasks are reversed. It has been a much discussed point whether or not habit reversal is more difficult for an older person.

Under controlled laboratory conditions in which habit strengths are made equivalent, old habits do not seem to be inordinately intrusive in the new learning by the elderly. What is difficult to standardize, of course, is the experience people have over their lifetimes. Indeed, in non-laboratory learning situations, the early phases of learning may occur somewhat more slowly in the older individual. This delay may be due to the intrusive effects of a mass of irrelevant or slightly interfering previous learning.

In practical terms, older adults may have to be given a longer early phase to overcome interference. But as learning proceeds, they may be expected to reach the same upper limits as young adults.

Surveys of learning under industrial conditions suggest that in verbal or abstract learning there are small, if any, differences between old and young workers. However, perceptual motor tasks do show interference. Again, these surveys may be comparing individuals with grossly different prior learning. Middle-aged machine operators, for example, may have acquired 20 years of habit patterns in contrast to habits of only a few year's duration in the young workers.

The attitude toward learning itself changes with age. All things being equal, the older adult is less set, or ready, to learn than he used to be. During the years since school, he can lose the desire to learn. Age may bring with it a tendency to solve problems on the basis of the already known, rather than to experiment with new solutions. Years of schooling per se appear to be more important than age as an indicator of the ability to learn during the work life. In the retirement years, differences in the ability to learn can be expected to be greatly influenced by health status and psychosocial make-up, not necessarily by factors correlated with age.

INTELLECTUAL ABILITIES

In addition to his sensory acuity and motor skills, man's ability to adapt to a changing environment depends to a significant degree upon his ability to solve problems. Important to successful problem solving is a clear grasp of the essential nature of the problem facing the individual. If an individual characteristically faces problems with highly familiar elements, he spends less time in analyzing the problems than in solving them by selection from a repertory of mastered solutions.

The greater the interval since formal schooling, the greater the likelihood that an individual will rapidly find a solution from the relevant items in his stored experience. And he will be less likely to take time to analyze the nature of the task confronting him. For example, it has been shown that vocabulary size increases over the adult lifespan. Words recognized serve as an index to the amount of information stored; however, increased stored information does not necessarily imply that the individual will show flexibility in the selection of relevant information. In other words, he may be a stodgy rather than a creative thinker.

The word "rigid" has been used to describe individuals who persist in a particular approach to a problem, even in the face of information that suggests change. Some related evidence suggests that older adults may seek absolute categories of truth or falsity in answering questions.

Again, years since formal schooling can result in a change in the way an individual evaluates his own performance. The person in school is quite sensitive to the quality of his performance in response to external demands. After many years of successful adaptations to the normal demands of life, the older person may not have the same sensitivity to unusual challenges. All things being equal,

therefore, a change in problem-solving attitudes toward unfamiliar tasks occurs as the interval since schooling grows.

Some evidence suggests that the thought processes of older adults tend toward simple associations rather than toward analysis. The weakness in solving abstract problems seems to be a reduction in the tendency to generate hypotheses about the nature of the problem and an orderly checking out of facts. While the interpretation of these findings is not settled, a change over the adult years in problem-solving orientation does indeed appear.

Tests. A number of standardized intelligence tests developed for children and young adults have been given to adults over the lifespan. While it is impossible to generalize from such test findings about the quality of mental performance, some of the findings have implications about aging and mental performance.

Tests that emphasize information, verbal comprehension, and arithmetic operations tend to show increases in scores with age from the twenties to the early sixties. Declines, however, are seen concurrently in tests involving spatial perception, arrangement of geometric forms, and decoding tasks. Thus, the pattern of adult intelligence-test scores changes with age.

Which particular test is the best single measure of adult intelligence depends upon the aspect of behavior under consideration. While speed of perception and mental decoding operations decline with age and are intimately correlated with age, information items, which normally increase with age, show the greatest correlation with health status in older adults.

Psychological tests apparently differentiate mental performance changes associated with advancing age from changes that have a pathological basis. Patterns of mental performance associated with organic brain damage in late life, presumably cerebrovascular, appear to differ from those which accompany normal psychophysiological aging. Changes in mental performance and in overt behavior also have been found to be associated with the development of cardiovascular disease.

Age changes in mental performance are not adventitious but somewhat predictable. This is seen in measurements of mental abilities of senescent one-egg (monozygotic) twins. Psychological tests of such twins over the age of 60 years indicate that both length of life and mental abilities appear to be controlled to some extent by hereditary factors.

Some individuals' mental abilities decline suddenly, apparently reflecting loss of health and heralding death. The more sudden the drop in mental test performance in late life, the greater the probability of imminent death. Since performance on psychological tests involves complex activity of the nervous system, it is reasonable to expect the test results to reflect not only disturbances in the brain but also functional disturbances elsewhere in the body. A new field of research and professional activity is being defined in this area, that of relating the behavioral measurements to the presence of latent or active somatic disease and the probable remaining length of life.

Rigid behavior in older adults can result from disease and brain damage. One study indicates that the largest part of the inflexibility of performance is related to non-verbal intelligence. The earlier discussed term "rigidity"—commonly applied to the behavior of older adults—is really too crude for scientists and practitioners to use. Most rigidity found in mental tests seems to result not from attitudes per se (as found in the young), but rather from changes in abilities. In the face of these and other findings, the use of the word "rigidity" to describe behavior tends to mask intrinsic relationships among these factors: (1) limitations on behavior choices associated with the number of years of schooling; (2) the years since formal schooling was completed; (3) organic brain damage; and (4) somatic disease that may influence the functioning of the nervous system.

WORK

An individual's capacity to work often exceeds the average workspan. What governs a worker's staying power? In periods of national emergency, older persons tend to stay in the labor force, but in periods of technological change or recession, older persons tend to be dropped from employment. Thus, employment or a trend toward early retirement is more a reflection of the economic condition of society than of a change in the capacity of individuals to work.

Our society is rapidly approaching the time when the average individual will spend more than half of

his life outside of the labor force. He will devote more than a quarter of his life to growing up and becoming educated before he enters the labor force; one quarter of his life will be lived in retirement. The period of education before entering the labor force has been lengthened substantially. More striking, however, has been the more than doubling of the retirement period.

There is no indication of a reversal of the existing trend toward reduced employment of older persons. In fact, increased retirement benefits are tending to make the post-65 period one of true retirement rather than one of simply being chronically unemployed. Retirement is a feature of technologically well-developed societies, and should perhaps be looked upon as a new stage in their evolution. If individuals are adaptive, retirement can be a "productive" phase for them personally, "productive" in a sense apart from their satisfactions while engaged as employed workers.

Particularly for men, the change from work to leisure after retirement is not easy. The acceptance of free time in retirement and its use in meaningful ways can involve many persons in a major crisis of personal values and reorientation. If retirement income is adequate, a period of two years is about the usual length of time for personal adjustment to retirement to be achieved.

The many commonly expressed criticisms or negative attitudes about retirement should not be confused with basic problems of income. Since retired persons have sharply reduced incomes, it is reasonable to expect that much of the resentment which they focus on retirement is attributable to loss of income rather than to having "empty" leisure time. There is a trend toward the acceptance of retirement by salaried persons, if an adequate pension is available. Self-employed persons are less inclined to retire since not only income but also higher status is maintained by continuing work.

Age and productivity. Industry's demand for workers with higher education puts today's elderly at a disadvantage in the labor market. A person now in his sixties or older grew up at a time when emphasis on mass education was starting to accelerate. Since the turn of the century, the average number of years of completed schooling has risen markedly.

Elderly workers contend with other influences on their employability. They tend to be in jobs and industries that are obsolescent or obsolete—that is, industries that can go out of business rapidly. Once out of work, elderly workers have prolonged unemployment. As new commercial processes appear, industries tend to employ younger workers. Besides having better educations, the younger workers are more willing to change place of residence to get or keep a better job. For the older worker, change often represents a move toward a less desirable position.

Factors of education and job mobility differentiate the old and young worker. But productivity changes little, if at all, over the lifespan of the worker in commerce and industry. Women office workers show little change in output from age 25 to over age 65. In general, workers rarely are pushed to the limits of mental or physical capacity on a job. Hence, declines in upper-limit potentials rarely are relevant to day-to-day functioning on the job. Other factors may be more important to an employer. The aging worker may be more desirable because he is less likely than the younger worker to change jobs. On the other hand, he may have low interest in retraining for a new type of job in the same company.

One of the ironies of modern industrial life is that machines have made possible a prolonged working lifetime, but industrial employers prefer to hire young workers. (The problem of age prejudice in hiring patterns will be discussed in the sociological portion of this volume.)

The working life cycle for women differs from that for men. Men remain in the labor force until retirement. Women enter, leave and return as family situations change. For instance, married women increasingly re-enter the labor force after the youngest child has left home or is in the last years of school. Re-entering the labor force in the late thirties or early forties, women appear to be stable workers without intense drive to get to the top. Often, they either stop working before their husbands retire or retire jointly.

Productivity in scientific and other intellectual pursuits is often a result of various factors. In general, these activities tend to be more revealing of upper-limit capacities than those involved in unskilled or semiskilled work. Scientific and scholarly contributions of merit tend to appear at age 20. Often, individuals hit their stride in creativity and productivity around age 30. Thereafter, a gradual

decline appears. Some individuals continue to make significant scholarly contributions beyond age 70.

What sets the age of great productivity? In many fields, the age is set by length of time in career preparation. In medicine, for example, the individual does not become fully trained until about age 30. Hence, discoveries and innovations in medicine appear to peak somewhat later in the life cycle than in chemistry, mathematics, and physics. In literature, there is a clustering of best works around age 30. But the rate of decline is more gradual in literature than it is in the sciences. Further, contributions to literature and art are more likely to occur after age 70 than contributions to the sciences.

These observations are based on data from men. Relatively few women have entered the sciences and learned pursuits; data on age and productivity are lacking. As data become available, we shall see if women have the patterns of men, and whether or not their significantly longer lifespans make a difference in the patterns.

One area of activity in which upper-limit capacity is assiduously tested is championship athletics. If we take the age of winning awards as an indication of the age of peak capacity, we find peaks at different ages for different sports. Boxing, baseball, and tennis, which tend to have early peaks, require a combination of rapid perception, rapid adjustment, and strength and agility. By contrast, golf has a later peak.

Age of peak performance is almost the same for sports as it is for scientific achievement generally, that is, somewhere between 28 and 32. However, the pattern of preparation is changing and the peaks can be expected to change, too. Athletes are being trained at earlier ages; increasingly, we see championship records set in the teens. Earlier academic training also may bring individuals to earlier fruition.

Income and age. Age of maximum income tends to be reached somewhat later than age of maximum intellectual productivity or sport performance. Income seems to rise continuously to age 55. However, there are differences between blue-collar workers and others. The incomes of unskilled or semi-skilled workers tend to reach a peak at an earlier age, with a decline thereafter. The incomes of professional individuals may continue to rise over their entire active work life, or at least until age 65, the common age of retirement. Insofar as income brings with it a sense of power and accomplishment, it is obvious that the blue-collar worker will experience a declining self-image more quickly than professional persons.

Given good health, adequate income, and an environment that contains proper psychological and social supports, only small reductions in capacity for work and for intellectual activity are to be expected over the normal work span. Often, however, the individual's emotional state and his social productivity begin to decline in early middle age—when his education no longer fits him for a desirable job, when he becomes ill, and when his relationships with other persons deteriorate.

PERSONALITY

Personality is difficult to define precisely. It refers to the distinctive styles in which individuals behave or react. How we react to developmental situations like marriage, the growing independence of adolescent children, and retirement is a function of our personality.

Some researchers use the concept of types of personality to differentiate individuals and predict how they will react to problem situations. The number of types of personality and, indeed, whether there are types, depends upon the measurements and the nature of the observations used in classifying individuals. Different classifications are used if one is employing such varied criteria as reaction to retirement, reaction to physical illness, or adaptation to family life. Different "types of personality" will emerge if one studies predictive factors related to personality in successful retirement or remarriage in middle or late life as contrasted with studies of cardiovascular disease in middle or late life.

The evolving personality or habit system of the individual imposes a bias or type of control over behavior. Thus, the way an individual reacts to body changes and disease is a function of his personality. With advancing age, the adult shows a reduction in drive level that includes reduced spontaneous physical activity as well as reduced sexual behavior. Depending upon his personality characteristics, the individual may regard these changes as an insult to his ego and throw himself into his activities with increased motivation, or he may react by passive retreat. Others may find physical changes

not at all insulting and in fact somewhat congenial. One factor of personality underlying the choices of behavior is the individual system of personal values. For example, if the individual places a high value on visible participation in the general social scene, the general drift with age toward lowered activity may be resented.

In the years over 60, there also appears to emerge a quality of effective (emotional) detachment from the environment. Older persons tend to have less emotion or ego involvement in their roles and activities than they had earlier in life. It is not yet clear that this is an adaptation to the fact that the environment is "moving away" from the individual in the sense that peers and relatives die, jobs and careers stop, and children grow up and go away. Possibly, such disengagement reflects reduced "ego energy" on part of the drive system of the individual. If so, older individuals presumably would have a lower capacity for effective involvement with other people, processes, and things.

Changes in interests and activities of adults over the lifespan do reflect long term developmental changes in motivations and habit systems. Personality is not a fixed system that is completed in early childhood. In fact, personality traits themselves seem to vary more over the adult years than do intellectual capacities. Research has shown that attitudes toward oneself change rather markedly over the adult years whereas those of personal values and vocational interests are relatively stable. Personality characteristics themselves are probably less important in determining the adaptations to changes in adult life than is intellectual capacity.

In addition to the normal patterns of adaptation to the events of life, individual physiological changes—including those in the nervous system—may dramatically affect an individual's emotional life and response patterns. One should always be curious about the basis of change in individuals who, having been relaxed and composed, suddenly become chronically anxious. Somatic change may result in behavioral shifts. Given somatic changes with non-specific or diffuse effects on the organism, the individual is placed in an uneasy relationship with his own body and may become suspicious and anxious.

Research on personality. The suspected relationship between age and rigidity has been a target of much research. One study indicated that personal rigidity was more closely related to the intelligence of the individual than to chronological age per se. This suggests that rigid behavior in the adult may be a function of intellectual level more than it is of a personality style of resistance to change.

In an investigation of the relationship of personality to retirement, the individuals' concepts of themselves and their styles of adaptation were studied. Generally, the older men seemed to be more satisfied with their earlier lives than were younger men. This suggests that, as they grow older, individuals realign their attitudes toward their early life problems and develop an acceptance of themselves and their past. The pre-retirement period frequently is accompanied by a sense of insecurity and instability; whereas in the period after retirement, the individual is less uncertain and defensive. Several types of successfully-adapting persons were described, among them:

(1) the *mature* type, who had a constructive approach to life;
(2) the *rocking chair* type, with tendencies to lean on others;
(3) the *armored* type, who had well-developed defenses; and
(4) the *angry* type, who often was hostile and who characteristically blamed others for his own limitations. Also, there was a group of poorly adjusted individuals described as *self-haters*.

One way of adapting to uncertainties in life is to deny their existence. This is a less desirable way of adapting than is the mature style of working things through as events occur. However, it is necessary to be sensitive to the fact that there are ways of coping with life that, although apparently pathological in character, have in fact led to a degree of stability and indeed success throughout the lifespan. Health practitioners should be aware that some older individuals will have a personality or adaptive style that might be thought of as psychopathological. There can be some late-life utility in psychopathology. While an individual may have functioned at a higher level of adaptation earlier in his life, nevertheless, the sustaining properties of his particular later-life maladaptations should not be denied.

One trait of older persons is often surprising. That is their willingness to be candid. A lower affective involvement with the content of his life can lead

the older person to be more intimate about such matters as successes and failures, relationship with spouses, financial achievements, and issues of religion and death. Such candidness on the part of younger persons might be viewed as peculiar whereas in the aged it is more usual. An interview with an older person may move more directly than an interview with a young adult. The young adult, not having achieved his goals or come to terms with himself, is more defensive in an interview situation.

There are many stereotyped preconceptions of the older person, such as the assumption that they invariably are anxious about death. Research indicates that younger persons are more concerned than the aged about death. Young subjects frequently believe older persons brood about death and dying whereas older individuals themselves are more concerned about the lack of money and the circumstances of living. To be effective, the health worker must understand the personality functioning and the motivations of older adults.

Sexual activity. Generally, the frequency of sexual intercourse declines linearly from a peak in the early twenties. To this extent, sexual intercourse follows other declines of activity. Married partners in their nineties may continue to engage in intercourse to orgasm, although less often than in early life. Health changes in the spouse may preclude sexual intercourse. Some aging partners welcome the lower sex drive, since sex for them has always been the source of uncomfortable relationship. There are also those who deeply miss sexual activity and may actively seek a new mate late in life, after the death of the spouse. Novelty in mating does appear to increase temporarily the frequency of intercourse.

Among psychophysiological factors involved in age changes in sexual behavior are: (1) hormone levels in the individual; (2) the thresholds of the nervous system centers controlling the elicitation of sexual behavior; and (3) the long-standing habit systems established in the central nervous system over the control of sexual behavior. These factors, changing in varied ways with age, result in considerable differences in the sexual behavior of older individuals in the same environments.

MENTAL HEALTH

Personality was previously defined as the characteristic ways the individual responds to life situations. These patterns of response can be more or less adaptive; some generally will lead to a reduction in tensions and conflict and others will increase the likelihood of lasting maladjustments and, indeed, mental disorder. There is a broad range of mental health problems, from minor issues of personality styles and discomfort to extreme manifestations of mental disease.

Mental diseases may be considered as disturbances of a long-lasting functional, anatomical, or physiological nature and as transient maladjustments. Mental diseases show a relationship with age. Forms of deviant behavior and mental illnesses vary in their frequency with age. From the fact that rape tends to be a young man's crime, it may be inferred that factors of behavioral control and hormonal output are involved. Each changes with age. Generally speaking, deviant behavior in society is typified by crimes of impulse in youth, and crimes of habit in old age. When there is unemployment, crimes against property rise in the younger group but not in the older group.

Suicide. One perplexing geriatric problem is the dramatic rise in male suicides. Suicide is a problem, particularly in the white population. The suicide rate in white men over the age of 75 is more than 7 times that of young adults in their early twenties. By contrast, the white female and the nonwhite male and female show no such consistent rise in the suicide rate with advancing age.

The evidence suggests that the white male reacts adversely to many conditions that accompany advancing age, such as illness and physical infirmity, reduced income, movement to a new residence, and lack of contact with previous colleagues. This reaction seems to reflect feelings of worthlessness. Apparently finding it difficult to accept the limitations of illness, some older men react by committing suicide in direct and violent ways. Those responsible for the health of older persons should be aware that white males may misinterpret or overreact to the personal implications of health change.

As more women hold lifelong jobs, the curve of suicide with age for females may become more like that of the male. Particularly, single career women may react to the same values and pressures as does the male.

Suicide and depression are highly age related.

Most older persons, at some time or other, are faced with physical illness and react in a depressive manner. With repeated episodes of bereavement and other psychological and social loss, depressive reactions in older individuals increase.

Mental illness. Brain disease of late life occurs more frequently but gets less clinical attention than do the characteristic mental illnesses of early life. Because senile individuals have fewer years of life remaining, mental hospitals and mental health clinics may be more concerned with the treatment of young schizophrenics than with senile patients. Between 1 and 2 percent of the population, under current standards of hospitalization, may be expected to be institutionalized for the first time for mental disease late in life. According to a statistical projection based on genetic considerations, senile dementia can be expected in about 4 percent of the population. Senile dementia seems to occur independently of, or in combination with, preexisting disease such as psychoneurosis, schizophrenia, or manic depressive reactions.

Communities vary in the institutionalization of individuals for the same manifest behavior. Deviant behavior tends to be more tolerated in older rather than younger persons. Perhaps deviant behavior in the aged is assumed to be an innocuous, "natural" consequence of aging. An older person is, in fact, more likely to hurt himself than he is to hurt others. Mental disturbance in the young is more likely to lead to harm to others. The extent of "queer behavior" that is tolerated varies with the nature of the community, whether it is rural or urban, or upper or lower socioeconomic class.

Mental illness in older persons can occur commonly as a side effect of somatic illnesses. Infectious diseases and undernutrition may help produce mental symptoms, and these may not disappear until some time after the original conditions are controlled.

Primary anatomical changes in the brain occur in a small proportion of older persons independent of the presence or absence of affective disorders and circulatory disorders. Thus, being schizophrenic neither raises nor lowers the probability of developing a senile brain disorder. The fact that primary senile brain deterioration occurs with the same frequency among those with functional psychosis as it does in the population at large indicates that these diseases have distinct etiologies.

Similarly, vascular and senile changes are distinct, though often concomitant. Advancing age does not lead characteristically to a reduction in blood flow to the brain. Individuals with functional emotional disorders have a favorable prognosis and are likely to be discharged from specialized facilities within 1 year. But patients diagnosed with senile brain disease or "organic brain syndrome" have only a 50 percent probability of surviving the year.

In patients with organic brain disease, cognitive functioning degenerates. However, there is the possibility of a social-psychological cushioning of the consequences of senile brain disorder. An individual with an affective interpersonal relationship with another person, e.g., a "confidant," is less likely to be precipitated into a mental crisis requiring hospitalization than is the isolate.

That such a small percentage of persons in the total population is institutionalized for mental illness in late life has two implications. First, it is obvious that a senile pattern of brain deterioration does not commonly accompany advancing age; when it does occur it is likely to be a pathological rather than a normal concomitant of growing old. Second, geriatric psychiatry is giving more emphasis to mixed causes of mental illness in older persons. Rather than search for a single diagnosis, one should seek a mixture of functional and organic factors. Diagnosis therefore tends to be multiple in older persons. Interactions take place among the physical illness, the mental illness, and the social environment.

BEHAVIOR AND CHRONIC ILLNESS

An area of research that could add a new dimension to practice involves the relationship of behavior patterns to the likelihood of developing chronic illness in late life. We can see that earlier life behavior patterns are related to the probability of developing cardiovascular disease. Hypertension tends to occur in persons who have a restless type of motor behavior, tend to be bothered by the inability to be active, reflect a feeling of the pressure and urgency of time, and place time pressure on others.

The relationship suggests that the medical histories of individuals should include information

about personality characteristics. At present, not enough is known to make inferences about the causal relationships between early behavior patterns and chronic illness outcomes. Whether there is a common constitutional basis for the early behavior patterns and disease outcomes or whether the behavior patterns and habits have resulted in chronic stress to the organism resulting in disease has not been established. However, when these relationships have been clarified, the way will be open for developing and applying new preventive health measures.

One of the areas where stress seriously taxes the individual's physiological limits is in bereavement. There is a marked rise in the death rate of spouses during the first year or two after the death of mates. Bereavement can be especially stressful to an individual who has preexisting health problems. Adaptation to bereavement eventually reduces the stress, but during the first year the surviving individual should receive increased attention from his physician and other health personnel. Health workers should attempt to see the individual several times during the early months and at least twice in the second six months following death of the spouse. Bereavement control measures, cushioning the physiological and psychological consequences in older persons, should be a new focal point of health activities. For the relatively isolated individual, such measures should be emphasized.

THE TERMINAL PHASE OF LIFE

The last few years in an individual's life contain not only new issues of a somatic nature but also some surprising psychological issues. This phase of life has just begun to be studied in an objective way. It makes a considerable difference, of course, whether the individual in his terminal stage is in his fifties, sixties, seventies, or eighties. Faced with knowledge that they have a chronic and fatal illness, individuals react in various ways. Some will persist in denying the truth, since they have lived their lives by denying reality; some will react passively; some will accept the information maturely; and some may welcome approaching death without reflection, especially if the last part of their life has been a troublesome period.

Many begin a review of life events, comparing the way they actually lived life with the way they had wanted to. Sometimes these reminiscences are misinterpreted as only a kind of garrulous behavior. They represent, however, an attempt to get the facts of life somehow in acceptable order so that the individual may retire from it with a degree of poise and contentment, to leave behind an acceptable image.

One result of the life review can be an increased desire "to build a monument." Individuals may also in dramatic ways attempt to resolve long-standing issues of social distance with siblings, relatives, and lifelong colleagues. Events of early life come flooding into consciousness. While the conflicts of children and young adults involve relationship with the mother, the psychological issues of middle age and late life apparently involve the individual's relationship with his father or father ideal. That is, during child development, the father represents the outside world and the standards of adult life. It is in this sense that the statement is made, "one is born of mother but dies of father." The role of sex differences in adjustment issues in late life and terminal phases is not known.

While losses occur throughout the lifespan and crisis points always provoke some manner of personal review, nevertheless, the dying person is in an unfamiliar psychological position. He can no longer use futurity, or the hope that the future will solve his problems, as a way of meeting issues of reality.

The dying person has four tasks. He must manage his reactions to the symptoms associated with his terminal somatic state and altered physiology; he must adjust his perceptions of the way he has lived his life; he must manage the impending separation from his loved ones and friends; and he must adapt to the transition to an unknown state (death).

In some individuals the terminal somatic changes preclude awareness of the details of life. The general sequence of death is: (1) social, when the individual no longer maintains his social relations with others; (2) psychological, when he retreats and withdraws himself from his lifetime involvements; and, (3) biological, when the vital organs no longer function. Given sudden biological failure, whether the individual is "a welcomer, accepter, postponer, disdainer, or fearer" of death will be of little importance.

Forms of reactions. Reactions to imminent death vary considerably. Some individuals may re-

quire psychiatric care. Physicians and psychiatrists themselves may be unprepared and, indeed, need support from colleagues when faced with diagnoses of fatal conditions. Thus, the forms of reactions, including the tendency to life review, may vary from a mild nostalgic recall to a severe depression with anxiety, guilt and suicidal tendencies.

Generally, however, the life review should not be viewed as a psychopathological phenomenon, but as a relatively common, essentially normal experience. This can be appreciated by comparing it with elements of the life review experienced earlier in life. For the woman it may come, for example, at the time the last child left home and she was faced with the fact that one of her major roles, that of mother, had come to an end. Death of a spouse or a close friend can also be a precipitator of a life review. It is of interest that much of the life review lies outside direct religious concerns, rather being directed toward resolving issues of earlier life. Life review serves to reduce tension. Often at retirement a man is aware that not everyone is unhappy to see him leave his job. In a similar way he may wonder whether his impending death might not be welcomed. Such a realization is tinged with a desire to improve certain relationships or at least improve the image of earlier life relationships.

As he approaches the end of his life, the older person needs more and more psychological support from fewer available sources. There is a need for sophisticated professional persons to help the about-to-die and the dying resolve psychological tensions. There is a role for health professionals in helping the individual die with dignity. The older individual may have strong feelings of inadequacy because poor health forces him to abandon responsibilities and leave important relationships unresolved. Self-reproach may be expressed until the dying elderly person can reconcile his death through a principle which renders acceptable his departure from his responsibilities and his unfinished life's business.

During the last few months of life, there is an increased focus on the body of the individual and an increased feeling that it is an inadequate instrument. There is also a growing and increased feeling of helplessness. Persons close to death apparently show a high interest in other people and high responsiveness to the environment.

Adaptations continually occur with age so that individuals who die in their sixties are, in a sense, dying prematurely and will show more deviance than persons who die in their eighties and nineties. An individual who has survived to age 90 has had 25 years longer to come to terms with the issues of life and death. If both somatic and environmental changes occur slowly enough, compensations—both psychological and physiological—can develop in the individual.

Perhaps one of the greatest disservices that can be done to the dying is to isolate them. Death in the normal course of aging is more of a process than an event. One study compared the content of 12 to 15 hours of interview for persons who died within the year of the interviews with those who survived. Individuals closest to the time of their death were much more interested in their immediate environment. Therefore, to deny them access to other people and to the content of their environment would reduce the likelihood that they could resolve their own departure with poise and acceptance. Denying the dying person access to others and to the information of his normal environment is perhaps a reflection of the attitudes of younger professional persons who are disquieted by their unresolved conflicts. The extension of health services should include attention to the social and psychological as well as to the physiological concomitants of dying.

Terminal change. The terminal stages of life form a distinct phase of aging. Research indicates that sudden declines in mental tests or psychomotor behavior should be viewed with suspicion as being indicators of possible serious changes. The abruptness of change in mental abilities often distinguishes the terminal state of the individual from previous adult life. Terminal decline commonly appears, therefore, as a sharp break or departure from a relatively stable series of measurements. The reason these may appear in intelligence tests and other forms of psychological measurement is that the nervous system's integrity is influenced by and reflects somatic changes elsewhere in the body. To this extent behavior is an indicator of the physiological integrity of the nervous system and may be more revealing than laboratory measurements of single biochemical or physiological functions.

SOCIOLOGICAL ASPECTS OF AGING

Every day 3,900 persons enter the ranks of the aged. On an annual basis, this means that 1.4 million persons reach their 65th birthday.

But every day 3,080 aged persons die, or 1.1 million a year.

Thus, the Nation's aged population grows by 820 a day, or 301,000 a year. This is like adding annually a city the size of Little Rock, Arkansas, to the U.S. population.

If the Nation's aged were gathered into a State of their own, the resulting population would be greater than that of any other State in the Union. But, of course, such concentration is not the case. Our 20 million elderly are scattered throughout the country among nearly 200 million persons.

The old age population has been growing. While the entire Nation grew from nearly 76 million to about 200 million since the turn of the century, the elderly segment grew from 3 million to 20 million. Thus during the past 69 years, while the total population tripled, the 65 and older segment grew to almost 7 times its former size, and today represents almost 10 percent of the total population.

It is estimated that by 1990, there will be 27 million elderly persons. If the U.S. birthrate remains relatively low, the proportion of the aged in the population is then expected to level off at about 10 percent.

In recent years, the rate of growth in the population 65 and older has slackened. In contrast to a 3 percent annual rate of increase for the decade 1950–60, the rate has averaged just under 2 percent during the Sixties.

Projections for the decade ahead indicate a growth rate for the aged population about the same as the rate for the total population. The ratio of the population aged 65 and over, consequently, is expected to remain a nearly constant proportion (about 18 percent) of the population in the "working ages" of 20–64 through 1985.

The growth in the aged population reflects in part an increase in average life expectancy. Since the turn of the century, average life expectancy at birth has increased from 47 years to over 70 years. The gain is due primarily to the overcoming of threats to life by serious diseases of childhood. However, the large increase in average life expectancy at birth has not been matched by a similar increase in average life expectancy at age 65. Those who survived childhood diseases and reached age 65 in 1900 could expect, on the average 11 or 12 more years of life. Today, men at age 65 can expect to live approximately 13 years and women, on the average, can anticipate another 16 years of life.

Of great significance in any planning for the aged is the fact that the aged population is getting older. The median age of this population segment has grown about a year in the last 19 years, from almost 72 in 1950 to almost 73 in 1969. Of every 100 older people today, 63 (almost two-thirds) are under 75; 31 (almost one-third) are between 75 and 85; and 6 are 85 or older. It is expected that in the years ahead, the growth in the aged population will be particularly great at the highest ages. The population 85 and older may nearly double over the years 1960 to 1985, in comparison to a 50-percent projected increase for the total population 65 and older.

The shift in the population structure of increasing proportions of "older" old people will mean that a growing proportion of retirees will have older

parents still living. The ratio of persons aged 80 and older to those aged 60 to 64 was 34 per 100 at the time of the 1960 census and is expected to double—reaching 67 per 100—by the end of the century.

More of the aged in the future will be women, and most of these women will be widows. Women 65 and older already outnumber men by a ratio of 134 to 100, and this disproportion is expected to rise to 150 to 100 by 1985.

A majority of all women 65 and older are now widows. The greater longevity of women, coupled with the fact that women usually marry men somewhat older, accounts for an increasingly heavy preponderance of widows in the older population, especially at the higher ages. Widows now number 6.2 million; by 1985, the number will soar to more than 8 million.

Because of the high proportion of widows, fewer than 4 in 10 women 65 and older—but more than 7 in 10 of the men—are married and living with the spouse.

Obviously, the level of schooling completed affects level of earnings, work and social status, communication and understanding, activities, interests and social attitudes. Of the 20 million elderly, half never went beyond elementary school; nearly 17 percent are illiterate or functionally illiterate; and 1 in 20 is a college graduate.

INCOME MAINTENANCE

Americans living in retirement are suffering from an income gap in relation to younger people. And as the gap widens, low income continues to be the most crucial problem facing most of the 20 million aged, as well as other millions just a few years under the age of 65.

The gap is continually widening. Median income of families with an aged head was 51 percent of that for younger families in 1962, but only 46 percent in 1967.

In 1967, only half of all families with a head 65 and older received as much as $3,928; this was barely half the median amount made by younger families. The contrast was even greater for incomes of older people living alone or with nonrelatives—in 1967, half had incomes no larger than $1,480, a median income only two-fifths as large as that of younger individuals. One in 4 of the aged living alone or with nonrelatives had as little as $1,000 or less in annual income.

At the other end of the scale, 13.5 percent of the older families—about 950,000—had incomes of $10,000 or more. Almost 38 percent of the younger families had incomes of $10,000 and above.

Of the 5.1 million aged unrelated individuals—many of them widows—one fourth, or 1.3 million, had 1967 incomes of less than $1,000, and another fourth had incomes between $1,000 and $1,500. Only one-fourth of the younger individuals—relatively half as many—had incomes below $1,500. Less than a tenth of the older individuals, but more than a third of the younger, had incomes of $5,000 or more in 1967.

A working paper entitled "Economics of Aging: Toward a Full Share in Abundance," prepared in March 1969 by a task force of experts for the U.S. Senate Special Committee on Aging warned that the Nation is facing what must be recognized as a worsening retirement income crisis, and underscored the need for a positive, comprehensive action program going far beyond measures taken in recent years. The report listed what the authors regarded as basic public policy questions which cut across the broad issue of economic security in old age. Some of these questions were:

What is an adequate level of income for retired persons?

What part in attaining this level should be played by governmental programs, by voluntary group action, and by individual effort?

Is the economic problem of aging a temporary problem that requires a different solution or a different "mix" of solutions for today's aged than for those reaching old age in the future?

Retirement Revolution. Our "retirement revolution" reflects two trends: at one end, an increase in the number of very old aged; at the other, earlier departure from the labor force.

More Americans are spending more years in retirement periods of indeterminate length and uncertain needs, causing a mounting strain on resources they had when they began retirement.

Significantly, the change from worker to retiree status cuts many incomes in half. For example, in 1967, a family headed by a person 65 or older who is still working full time the year round had a median income of $7,418 as compared with $3,928, the median income of all families headed by an older

person. These families comprised but 15 percent of all elderly families. For fully-employed aged workers living alone or with non-relatives, the median income was $3,859, as compared with $1,480, the median income for all elderly living alone. About 8 percent of the unrelated elderly are in this category.

Retirement years are especially severe for an ever-rising proportion of women—most of them widows. Increasingly, the rising population of widows is attempting to live independently, even if independence is purchased at the price of poverty.

Inflation erodes already inadequate incomes over extended retirement periods. An annual rise of only 2 percent will reduce the purchasing power of fixed incomes by 18 percent after one decade and by 33 percent after 2 decades.

Increasingly, economists point to the fact that Social Security, private pensions, and other forms of retirement income are not improving fast enough to reverse or significantly counter present economic trends.

Sources of income. In the aggregate, the total income of the elderly seems immense. While no precise figure is available, the total annual income of the aged population—workers and retirees—is estimated at 50 billion dollars.

The aggregate amount can be misleading, however, unless it is recognized that nearly $1 out of $3 is in the form of earnings, a source which contributes only to the small minority of the aged who are employed. Four out of every 5 older persons are *not* in the labor force, and the 1 in 5 who does work tends to concentrate in part-time and low paid employment.

Earnings represent 32 percent of the aggregate money income of the aged. Retirement benefits account for almost two-fifths of the total: Social Security benefits, 30 percent; railroad retirement and government employees retirement benefits, 6 percent; private pensions, 3 percent. Interest, dividends and rents account for 15 percent of all elderly income. Public assistance and veterans' benefits account for 5 percent and 4 percent, respectively.

For most of the elderly, Social Security benefits represent the major source of income. At the start of 1969, about 16-1/2 million people 65 or older actively participated; more than 1 million others are eligible for benefits except that they—or their spouses—have not yet retired. Persons currently receiving benefits or eligible to do so on retirement make up 92 percent of the total population over 65. Average Social Security benefits in 1968 were: $98.90 for a retired aged worker; $51.20 for the spouse; $86.50 for an aged widow.

As a measure of the important role of the Social Security benefit in maintaining income, the Social Security Administration found in a survey conducted in 1963 that a large number of beneficiaries had little cash income besides their benefit. In 1962, about one-third of the non-married beneficiaries received less than $150 in money income other than benefits during the entire year. One-fifth of the couples had less than $300 in addition to their benefits. There has been little improvement in this respect since 1957, when the income of beneficiaries had been last studied.

Issues and proposals. Congress has had many proposals for legislation to maintain the purchasing power of the elderly and to maintain their standard of living relative to that of the working population. Suggested methods included such approaches as improved and adjusted pensions, constant purchasing power bonds, tax relief, increased public services, and improved welfare payments.

The issues involved are among the most complex in our society. A basic issue is the extent to which the working population is willing and able to provide for the elderly and other dependents through governmental and other means. The ratio of the number of older persons to the number in the "productive" ages (18-64) has changed very little (from 13 per 100 in 1950 to 17 per 100 in 1966). The ratio of under-18 dependents has grown much faster but is more than offset by increased economic productivity.

Experts note that although there have been increases in the benefit amounts paid to Social Security recipients during the past several years, these increases have been more than offset by the rising cost of goods and services. To counteract the effects of inflation on limited budgets of the elderly, many legislators are calling for substantial increases in average cash benefits paid to Social Security recipients.

In May 1967, upon a directive from the President, a Task Force on Prescription Drugs was established by the Department of Health, Education, and Welfare to undertake a comprehensive study of

the problems of including the costs of prescription drugs under Medicare. The final report of the task force, released in February 1969, pointed to the great need of the aged for appropriate prescription drug therapy and the inability of many in this age group to afford the required drugs, and recommended an out-of-hospital drug insurance program under Medicare. Several alternative approaches were suggested, including complete coverage as well as various methods involving deductibles.

Early retirement is a developing trend that could seriously impede attempts to improve the income position of future aged populations.

Since 1961, the Social Security law has permitted individuals to take an actuarially reduced benefit as early as age 62. More than half of all people now retiring do so before age 65 and for the rest of their lives get benefits that are substantially less than what they would have received if they had waited until they could receive their benefits in full. Evidence indicates that generally they claim benefits early because they suffer from failing health or cannot any longer secure employment—they thus have little real choice. This is true, at least, for most of the men; women, of course, more often are secondary earners and may have earned their retirement rights many years prior to the attainment of retirement age, having left the labor market long before.

The average benefit for men who take the actuarial reduction is about $30 a month lower than the average benefit being awarded to those retiring at 65 or above. There is a real danger that in the long run, if this situation continues, it may result in a reversal of the long-range trend of reduction in the old-age assistance rolls. This is due to the fact that the longer a person is in retirement, the more likely he is to have used up whatever resources he took with him into retirement, and the more he becomes wholly dependent on his Social Security income. Thus these people taking low early benefits may later on have to apply in increasing numbers for assistance. Accordingly, this serious and developing problem may require some modification of the actuarial-reduction provisions.

Work. The aged population is primarily a retired population. This is a reflection of a highly technological society in which the accent is on youth. The policies and customs that have set age 65 as the time of retirement have roots in history. Germany's Chancellor Bismarck in the late nineteenth century established a pension system for persons aged 65 or older, but at that time relatively few persons survived to that age. Age 65 for retirement was confirmed in the United States by the Social Security Act of 1935, which represented, in part, an attempt in the depression to open up jobs for the younger worker by encouraging retirement, and, in part, to support the often unemployed older worker.

Since the turn of the century, the labor-force participation of men aged 65 and older has plummeted. In 1890, 68.3 percent of older men worked. By 1968, the proportion was 27.3 percent. Today's employed elderly person is likely to be self-employed, probably in the less well-paid and frequently marginal occupations and industries, in agriculture, or in part-time employment. Among the 2.4 million aged persons who worked in 1968 in non-agricultural industries, almost a third of the men and half of the women worked part-time.

Labor-force participation rates for men aged 45 to 65 have remained fairly stable at 91 percent overall. But starting with middle age, the participation rates fall at a rate increasing with age. Also with increasing age, the proportion of employed men in farm labor, farm management, and service occupation grows and the proportion in skilled and semi-skilled occupations declines. Aging women are more likely to be in managerial and household work and less in clerical and semi-skilled jobs.

Once unemployed, older workers tend to remain unemployed significantly longer than do younger workers. Many who become unemployed past age 60 are, in effect retired.

HEALTH

Variations in health care expenditures the year before and the year after Medicare went into effect reflect greater use of medical care services by the aged and an increasing proportion of public funds used in payment of these services.

In the fiscal year ending June 30, 1966, the health care bill for the older population totaled $7.8 billion, representing an average expenditure of $423 per person. In the fiscal year 1967, the first year Medicare was in effect, the total bill rose to $9.2 billion, with a per capita expenditure of $486—an in-

crease of $63, or 15 percent, over the comparable per capita expenditure in 1966. The $486 per capita expenditure in 1967 was about 2-3/4 times the average for younger persons ($177).

Most of the increase in total expenditures was for hospital care, the average increasing almost 25 percent, from $182 to $222. Expenditures for physicians services for the aged rose 20 percent on a per capita basis (from $72 to $85).

During this same period, the portion of the total bill paid by all public programs for older people doubled, going from 30 percent to 60 percent (35 percent from Medicare and 25 percent from all other Federal, State, and local programs). Primarily as a result of Medicare, the portion of the total expenditure financed from public funds rose markedly in the first years of operation—from $130 per aged person in 1966 to $286 the following year. Concurrently, there was a less sharp drop—from $294 per capita in 1966 to $200 in 1967—in expenditures classified as from private sources.

For other professional services, including dentists' services, the average expenditure per person was virtually the same for each age group (about $22), with the higher dental expenditures for the non-aged person offset by the higher expenditures for the aged person for services of private duty nurses, physical therapists and other medical professionals.

Although the aged represent slightly less than 10 percent of the total population, they paid about 25 percent of all national costs for prescription drugs in 1966, mainly because of their need for repeated dosages to treat chronic diseases such as heart problems, mental and nervous disorders and arthritis. Compared with the non-aged, the aged spend almost 3 times as much for drugs and drug sundries ($65 and $23, respectively).

Although the burden of drug costs falls most heavily upon the elderly, it does not fall evenly upon these individuals. A 1968 estimate, obtained for the Department of Health, Education, and Welfare Task Force on Prescription Drugs, indicates that 20 percent of the elderly will have no drug expenses, while the costs will be less than $50 for 41.5 percent, between $50 and $99 for 19 percent, between $100 and $249 for 15.5 percent, and $250 or more for 4 percent.

The widest disparity in health expenditures among the aged and the under-65 age group is for nursing home care, for which $64 was spent for the average aged person during fiscal year 1967, compared with only $2 per person under age 65.

Almost all the elderly—4 out of 5—report at least one chronic condition or impairment. But for many, the condition or impairment is far from a critical factor in daily living. Half the older persons with a chronic condition report either no limitation of activity of any kind or some limitation that is not in their major activity. Almost 1 in 5 with a chronic condition, is an invalid in the commonly accepted sense of that term—that is, in chronic ill health and disabled for active life, and 1 in 3 is partially limited in activity level. The most frequently reported activity-limiting conditions are cardiovascular (21.8 percent), arthritis and rheumatism (20.7 percent), and visual problems (9.5 percent).

Today more people reach the older years (Table I), and subsequently become subject to chronic health problems requiring long-term medical care. The proportion of patients suffering from chronic illness has dramatically increased over the past years. For example, in 1900, 25 percent of deaths were attributable to heart disease, cancer, and cerebrovascular accidents; today, 70 percent of deaths are due to these same disease entities.

Long-term Care. The large prevalence of chronic conditions means that aging people often require "long-term care" involving hospitalization for more than 30 days rather than a week or two. Social and scientific changes have made inadequate the traditional reliance on individual and family responsibility for the care of the chronically ill. Family members often are not available and, even if they were, long-term care is difficult because of the need for special knowledge. To meet this need, the development of home health agencies and their services in the home has come to the forefront.

Long-term care, emerging as a spectrum of care in its own right, has these characteristics, among others:

—It has been largely unplanned on a community basis.

—A considerable number of long-term patients are medically indigent and their care has been thought of usually in terms of institutionalization in a custodial facility.

TABLE I: AVERAGE REMAINING YEARS OF LIFE AT BIRTH AND AT AGE 65 IN 1900 AND IN 1967

	At Birth			*At age 65*		
	Both sexes	*Male*	*Female*	*Both sexes*	*Male*	*Female*
1900	47.3	46.3	48.3	—	11.4	12.1
1967	70.5	67.0	74.2	14.8	13.0	16.4
Increase	23.2	20.7	25.9	—	1.6	4.3

Source: U.S. Administration on Aging

—Long-term care is too expensive and demanding for most families. Not only does the poverty-stricken family need help, but many families who by today's standards are not indigent need the services and some help in paying for them.

—Long-term care requires multiple services.

The economics, technology, and professional quality of long-term care are improving as the elderly population changes and society becomes more attentive. The delivery of health services is changing in a direction that may help sustain elderly persons longer in the community. Greater emphasis on organization, planning, and teamwork—not only among practitioners in health but also in allied disciplines—will benefit all patients, most particularly the elderly who suffer multiple health and social deficits. For example, we are beginning to see the emergence of an organization to manage the health and social problems of the elderly as part of the hospital; the neighborhood health center is emerging in a few places as a satellite of a hospital or an extension of group practice. Both facilities are in the direction of one-stop health and social service, tapping the expertise of medical and social agencies conveniently for those least able to search them out.

In part, these trends represent extension to the health industry of approaches used in other industry, such as program planning and budgeting, cost efficiency, and even market research. On the last, there is growing emphasis on demographic factors (income, race, education) that influence the consumption of medical care services, and even the giving of it.

Sociology and Practice. Practitioners as well as patients are being studied sociologically. For example, studies are directed at determining whether the advent of Medicare has changed the attitudes of nurses toward the chronically ill. This is based on the premise that nurses, as others, tend to respect paying over non-paying patients. Other sociologists are studying why practitioners favor certain types of patients and not others.

Another element in shaping the medical future will be greater emphasis on preventive health practices, including the use of multiple screening tests and automated clinical laboratories. It may well be that widespread application of preventive care in time may lead to a reduction in the cost of Medicare and other health efforts for the aged.

A whole new attitude toward nursing homes is arising in our society, which for so long has tolerated hazardous conditions in these facilities. And behind this change is the consensus that the aged patient must receive the best in continued care and is to be rehabilitated as far as possible.

Also under study are the sociological implications of "being sick." In the minds of many people, the sick role is associated with age. Because the aged are considered to be exempt or to be deserving of exemption from the responsibilities of the productive adult, illness and hospitalization are only a dramatic climax to the loss of their roles in society. Research into adaptations to illness and long-term care may show ways of preserving participation in social roles.

Mental Health. Much of the emotional disturbance in old age is the result of the loss of certain social roles and the search for new ones. The aging not only face retirement but also face further changes, particularly in health. Anxiety about the present and future may result in physical and mental health problems. These anxieties must be considered by those who have the responsibility for caring for older people.

Two of the most common mechanisms of adjusting to problems of aging are hypochondriasis and denial. In hypochondriasis, the aging person becomes excessively concerned with declining health. He complains, makes frequent visits to physicians, and busies himself in self-doctoring with patent medicines. Denial means the refusal to recognize declining health and the resistance to receiving medical care and advice.

The desire for good health may be so much a personal need that decline comes as a trauma, leading to depression and disorganization of self and role behavior. For most of the elderly, the realization is unpleasant but not shocking. Adjustment with a minimum of social and emotional disturbance requires much effort and often much assistance.

Social isolation apparently predisposes certain types of personality toward mental illness. Loss of social role by retirement or widowhood may result in mental illness. Perhaps the quality of social contact and participation means more than the quantity in preserving mental health.

Because people have varying social needs, their adjustments must be gauged in terms of past style of behavior as well as current social life. However, there is little doubt that the form of mental illness in old age often reflects the realities the elderly have. How "unreal" was the following paranoid episode of an institutionalized patient? He would not sleep because he felt someone was stealing all his possessions—clothes, pictures, mementos—and, when everything had been stolen, then he (the patient) would die. The murderer, however, would never be caught because there would be no evidence that he (the patient) ever lived.

SOCIAL AND LIVING ARRANGEMENTS

Most of today's elderly maintain their own households. The older the age group, the higher the proportion who move into others' housholds. This is a reflection of health and income status and of the death of a spouse (usually the male first). The proportion of women living as parent of the household head rises from 6 percent at age 60–64 to 24 percent after age 74. For men, the shift is from 3 percent to 12 percent. Institutional living also rises with age, though only 1 in 25 elderly persons lives in an institution.

Ninety percent of the men and 80 percent of the women head up their own households, including some who live alone or who have taken non-relatives into their homes.

The elderly tend to live in older housing, either the cheaper accommodations they have had to take for economic reasons or homes which they own and in which they raised families. About half the retired couples in cities own their own housing; the rural proportion is much higher. An estimated 40 to 50 percent of older families or individuals are in the wrong housing, some in homes too large and expensive for them, many in dilapidated or inadequate structures (often lacking hot water and a private, inside toilet). Almost 1 in 4 older households has no telephone. Most elderly people cannot afford adequate housing.

Currently, there is a good deal of activity in providing housing for older people which is located close to community facilities and designed for convenience and safety. Much of it is equipped to provide special services, and some of it is subsidized to bring rentals to levels that can be afforded. It is believed, however, that the total volume of housing for the elderly constructed thus far probably does not equal 5 percent of the need, and much less than 5 percent of the need for low-income households.

The elderly apparently are not being abandoned by their adult children, even though the adult children's resources are often not up to providing for meeting the needs of *their* children as well as their parents. As average lifespan increases, average workspan has begun to shrink—not only because of earlier retirement but also because of lengthening preparation for the working years. Out of this limited workspan, the individual must finance his routine needs, the increasingly expensive educations of his children, and, in part, his own retirement. Thus, one observer has suggested that the commandment to "Honor Thy Father and Thy Mother" may have

been really put to the test for the first time in the past half century.

Parents and children. Social contacts between parents and children are not necessarily reduced because the parents grow old. These contacts may increase as children settle after marriage or the retired man has more time for his family. The housing arrangements of young adults may exclude elderly parents, but older people often live near at least one child and visit that child on a regular basis. In addition to the 1 out of 4 older persons who lives in the home of an adult child, 1 out of 4 lives on the same block or within walking distance of a son or daughter, and an additional 1 out of 4 lives within commuting distance (by public conveyance) of a son or daughter. Separate households do not adversely affect the family unless there are other factors which complicate or make it difficult to maintain a relationship between a parent and child.

A 1965 survey of aging people who had changed residences indicated that the reason for the change in housing was most often personal convenience (including economy and climate) but many admitted moving for no reason than to be where the children are and, thereby, maintain social contact within the family. Children may also be more accommodating than they were once thought to be. For example, they may plan and purchase housing with facilities (usually a bedroom and bath with private entrance) for an in-law.

Adult children often take in their parents during illness, widowhood and other crises. Sometimes the arrangement becomes permanent. Relatively few aged persons are abandoned by their children to institutions; in fact, institutionalization is usually a last, desperate resort. Nonetheless, some elderly persons who are in institutions could live in the community if suitable housing, activity centers, and services were available.

If retirement income, housing, and community facilities were to improve to the extent that more people could be self sufficient and live independently for longer periods, one could well speculate that this could lead to an evolution of intergenerational relationships. More wholesome and natural relationships among generations would replace those enforced by moral and legal sanctions.

Older people without children or without a desire to locate or stay near a child may have the option of retiring to a place where services are oriented to their needs. One such place is the retirement community. It has the advantages of standardized accommodations designed for elderly persons, such as bathrooms with grab-bars, entrances that permit wheelchairs to move easily, and floor plans without steps or protruding obstacles. A retirement community may have its own clinic. A few include prepaid health insurance in a monthly rental or mortage payment. They may offer their own security police and have rules excluding child residents.

There are many arrangements and degrees of age-segregated living other than those of the retirement community. Examples include apartment houses, hotels and boarding houses catering exclusively to the elderly. There is some evidence that community and intergenerational relationships are better among those in retirement housing than among elderly persons who are scattered throughout the community. Nevertheless, the social policy issue of the extent to which the government should foster separate housing or separate communities for the elderly is far from settled, since the factors to be considered are numerous and complex.

USE OF LEISURE TIME

What do elderly people do with their leisure? Some find satisfaction in retirement communities which offer a variety of sports and other amusements. Some stay in their old communities and find satisfaction in civic, church, adult education, clubs, senior citizen organizations and other activities. Relatively few people participate actively. Studies indicate that visiting, reading newspapers and magazines, watching television, gardening, and sewing are the activities in which older people most commonly engage. The majority of older persons seem to increase their involvement in earlier roles and do not develop new ones.

One of the reasons why they do not engage in more retirement activities has been attributed to the thought that society has not yet developed expectations for older people. In the absence of roles defined by society, many persons, confronted for the first time with a totally free choice of activities, may lack the necessary resourcefulness or experience and do not know where to turn. Poor health, lack of energy, and limited mobility are certainly compelling factors for many people, and insufficient income

for proper nutrition and clothing and for bus fares and membership fees no doubt deters or prohibits others from taking part in social, recreational, and creative activities that some find particularly engaging. The desire to gradually disengage from responsibilities and activities and to spend increasing time in contemplation may also have intrinsic appeal.

Importance of meaningful activities. Social adjustment is not necessarily made by simply filling time with busy work. Some older people who are no longer working have high morale and personal satisfaction when they voluntarily participate in activity which affords them status, recognition, and achievement. Even activity which provides a social group as a replacement for former co-workers may not be enough. People must be able to express themselves in ways which have meaning for others as well as the members of their recreational group.

The American concept of work and leisure values activity of any sort over non-activity and emphasizes efficiency, functionalism, and productivity. Although leisure has a definite value, to make a career of recreation, hobbies, and the like, goes against deeply instilled values.

Leisure activities with certain characteristics apparently facilitate the social adjustment of the elderly. These are:

—A recurrent activity which: (1) is organized by an agency, practitioner and/or members of a group, (2) is visible to a social audience, (3) permits a range of participation, and (4) sponsors the formation of new roles;

—An activity which may be created for, and possibly engaged in, only by older people, yet is appropriate in terms of the traditional and contemporary social values of the American population in general;

—An activity into which aspects of work may be introduced, as explained in the following way by an elderly wife: "Hobbies are eccentric when you never make anything (useful) out of them or get anything (monetary) out of them."

Attempts have been made through recent Federal legislation, including the Older Americans Act and the Economic Opportunity Act, to engage older people in community action projects and voluntary services. These attempts bespeak growing awareness of the presence and circumstances of older people.

POLITICAL POTENTIALS OF THE AGED

One of the questions for the future has to do with whether the elderly will become a highly active political force. Part of the answer depends on our society's response to aging and the extent to which the needs of the elderly are considered in terms of more adequate basic incomes and participation in the rising standards of living and the provision of health and welfare services.

Another part of the answer depends on the extent to which the elderly recognize a community of interest and overcome their reluctance to identify themselves with a special age group.

As the population of healthy, articulate retirees grows, will it tend to become a political constituency? In the past many older people have doubtlessly departed from their traditional political sentiments toward those that they believe to be in their more immediate interest. But with this there is varying opinion as to whether a political coalition of the elderly is in the making.

The elderly increasingly depend on government support, and this may add to their "politicization." More than 8 in 10 aged couples and almost 7 in 10 non-married older persons receive retirement benefits, principally under Social Security or other public systems, such as public assistance or veterans' pensions. Private pensions represent a small part of the aggregate income of the elderly population.

CURRENT AND FUTURE PERSPECTIVES

So far we have delineated some of the objective conditions facing the aged in our society. Now we turn to some of the more general social outcomes of this situation.

Subculture of Aging. A subculture develops within a society when the members of any one group of people interact with each other more than they interact with other people.

There are several reasons for this happening. The group members have a great number of interests, experiences and problems in common. The members are excluded from interacting with other

people. The formation of the group provides its members with a meaningful audience and the opportunity to create new roles.

The following conditions in our society serve to make a special group of the aging:

(1) The growing proportion of people who live beyond age 65 has increased from 4 percent in 1900 to 9.6 percent in 1969. These 20 million people could become members of a special social group of the aged.

(2) Advances in both therapeutic and preventive medicine, and the control of acute and communicable disease as well as other public health achievements have resulted in a larger number of people reaching age 65 in good health. The elderly population has the stamina to participate socially.

(3) Increases in the standard of living and level of education have resulted in a greater number of people reaching retirement age with funds, knowledge, and skill with which to engage in organized activity.

(4) More people are growing old and therefore more people are subject to the debilitating effects of chronic illness. This situation, coupled with reduced income in retirement, prompted Federal legislation to provide for a program of medical care for the aging. In its turn, this legislation tended to give older people a sense of common need and purpose as a group.

(5) There has been a decline in the number of self-employed who could work as long as they wanted. Meanwhile, retirement increasingly removes people from work and some of their other interactions with persons of all ages.

(6) Social welfare services have brought the aged together and increased the opportunities for older people to identify with each other. The increasing number of retirement homes, nursing homes, housing projects, etc., sponsored by public and private agencies has tended to separate older people from the rest of society.

(7) A small portion of the aged has acted to segregate itself from the general population by living in retirement communities or specific locations with mild climates and by joining special interest groups such as Golden Age Clubs and other senior citizens' organizations. Participation in age-based activity reinforces the propensity for segregation.

Aware that their problems are not only individual but collective, older people have begun to talk in terms of collective social action. Their support of Federal legislative proposals in their interest signifies to some observers that the elderly may be on their way to becoming a voting bloc and political pressure group.

The conditions which have prompted the elderly to recognize themselves as a group with special interests have prompted others to help them. Professional persons interested in the biological, behavioral, and sociological aspects of aging have created the discipline of gerontology in the last few decades. The efforts of social workers, philanthropists, public health specialists and others in business, labor and government have led to special programs and facilities.

Perhaps the most conspicuous efforts for the elderly have come at the political level. The 1935 Social Security Act is a landmark in legislation for the aged. The Social Security system has been expanded by several Congresses. The White House Conference on Aging in 1961 was another reflection of concern for the elderly. In the years following came Medicare, the Older Americans Act (establishing the Administration on Aging), and other laws covering many problems of the elderly. Government expenditures for research in aging and grants to States and communities for programs for the aging have grown apace. In 1968, legislation was enacted by the Congress to authorize a White House Conference on Aging in 1971.

Sociologists expect, however, that tomorrow's elderly will begin to be different from today's. They will reach the retirement ages with somewhat better financial, health, and attitudinal characteristics, in proportion to the success of present efforts to solve health, housing, income maintenance and other problems.

The change in the elderly population will not be abrupt. We can see today a number of elderly persons who flourish in retirement. Through pension and Social Security benefits, they may have the money to support activities they like. They may be able to buy the clothing and services that help them to be attractive. They may have the education that

enables them to adapt to life without work, to minimize the impact of chronic conditions or to get the help they need to minimize them. If these people are surprising, the surprise may be due to the contrast with society's stereotypes.

Negative attitudes toward aging and the elderly prevail as much to the detriment of the young as to the old. The denigration of old age is related to much of the current identity crisis of youth, according to Erik Erickson. In *Insight and Responsibility*, the psychologist says:

"As we come to the last stage we become aware of the fact that our civilization really does not harbor a concept of the whole life as do the civilizations of the East . . . If the cycle in many ways turns back on its own beginnings, so that the very old become again like children, the question is whether the return is to a child likeness seasoned with wisdom—or to a finite childishness—It can only weaken the vital fiber of the younger generation if the evidence of daily living verifies man's prolonged last phase as a sanctioned period of childishness. Any span of the cycle lived without vigorous meaning, at the beginning, in the middle, or at the end, endangers the sense of life and the meaning of death in all whose life stages are intertwined."

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